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Chapter 6: Pressure Injuries and Ulcers

Aimée D. Garcia; Stephen Sprigle

INTRODUCTION

CHAPTER OBJECTIVES

At the end of this chapter, the learner will be able to:

1. **Identify the factors leading to pressure injury and ulcer development.**
2. **List strategies for prevention of pressure injuries.**
3. **Complete a risk assessment scale to determine pressure injury risk.**
4. **Effectively implement strategies for pressure load management.**
5. **List and define the categories of bed types.**
6. **Describe proper wheelchair positioning to prevent tissue injury.**
7. **Define the NPUAP pressure injury and ulcer stages.**
8. **Discuss the elements of proper pressure ulcer treatment.**

There are many different wound etiologies that occur on patients and require medical intervention to achieve full healing. In the hospital and long-term care settings, the most common type of wound is the pressure injury, and the most common populations in which pressure injuries occur are the elderly and patients with spinal cord injury. In the spinal cord injury population, 25–40% of individuals will develop a pressure injury in their lifetime, and 70% of pressure injuries occur in patients over the age of 70.[1,2]

The National Pressure Ulcer Advisory Panel definition is as follows: a pressure injury is localized damage to the skin and/or underlying soft tissue usually over a bony prominence or related to a medical or other device. The injury can present as intact skin or an open ulcer and may be painful. The injury occurs as a result of intense and/or prolonged pressure or pressure in combination with shear. The tolerance of soft tissue for pressure and shear may also be affected by microclimate, nutrition, perfusion, comorbidities, and condition of the soft tissue.[3] Unlike other types of wounds, pressure injuries and ulcers are often viewed as a visible sign of neglect, although there are situations in which development of skin breakdown is unavoidable. Pressure ulcers are a significant cause of morbidity and mortality and occur in all care settings, from the home to the intensive care unit. The annual cost of treating pressure ulcers in 2004 was noted to be £1.4–2.1 billion in the United Kingdom, which was equivalent to approximately 4% of the total National Health System budget, and $2.2–3.6 billion in the United States for the same time period.[4,5] The cost of a single pressure ulcer has been estimated to increase the cost of a hospital stay by $2,000–$11,000.[6]

The population is rapidly aging, with the fastest growing segment of the population being individuals over the age of 80,[7] thus it is expected that the number of pressure ulcers, and therefore the cost to the healthcare system, is going to increase dramatically in the next 20 years *unless* significant improvement can be made in prevention. Despite the many advances that have been made in the field of medicine, these advances have not significantly impacted the prevalence or incidence of pressure ulcers.

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Editor's note: Because of the recent discussion about definitions of pressure damage, in this chapter *injury* refers specifically to any deep tissue damage with the skin intact and *ulcer* refers to any tissue loss that involves the skin. Specific terms used in references are also used in the text; otherwise, in some cases the terms may be used interchangeably.

PATHOPHYSIOLOGY

Pressure injuries and ulcers occur primarily due to immobility; however, there are other factors such as moisture, friction, and shear that also impact the formation of tissue damage and skin breakdown. Moisture, as a risk factor for skin breakdown, can be defined as excess fluid against the skin (**FIGURE 6-1**). This can occur secondary to incontinence, wound drainage, or excessive perspiration. Excess moisture causes maceration of the skin, which makes it more vulnerable to friction and shear forces. Friction is the force caused by two surfaces rubbing against each other (**FIGURE 6-2**). These forces abrade the epidermis and lead to a decrease in strength and skin integrity, as well as possible increase in shear in the deeper layers of tissue. According to a white paper published by the NPUAP in 2012, friction alone does not cause a pressure injury; however, it may contribute to harmful shear and stress in superficial tissue cells. The heels are the most common site of friction forces, and damage commonly presents as a blister, which can be filled with either serous fluid or blood, depending on the depth of the tissue injury (and appropriately termed a pressure injury).[8]

FIGURE 6-1

Moisture on skin Moisture is one of the contributing factors to pressure ulcers, especially in the perineal and perianal areas. The changes in skin as a result of prolonged exposure include maceration, blanched color, and a papillary-like texture, as seen on the area around this sacral pressure ulcer. The drainage can be fecal, urinary, or wound moisture. In addition, the moisture can cause changes in the skin pH, especially in the case of fecal incontinence, which further weakens the skin and increases the risk of tissue damage.

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FIGURE 6-2

A, B. Friction is defined as the force that results when two objects rub against each other. When skin moves back and forth over a surface (eg, heels on the bed linens), friction occurs and causes erosion of the epidermis and/or blistering between the epidermis and dermis. The schematic demonstrates the small surface area of the heel that becomes the surface area in contact with the bed surface, and the photograph illustrates the most common source of friction, heels rubbing on the bed linen.

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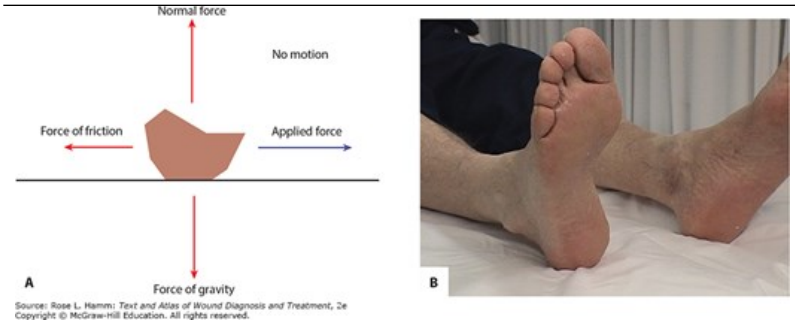
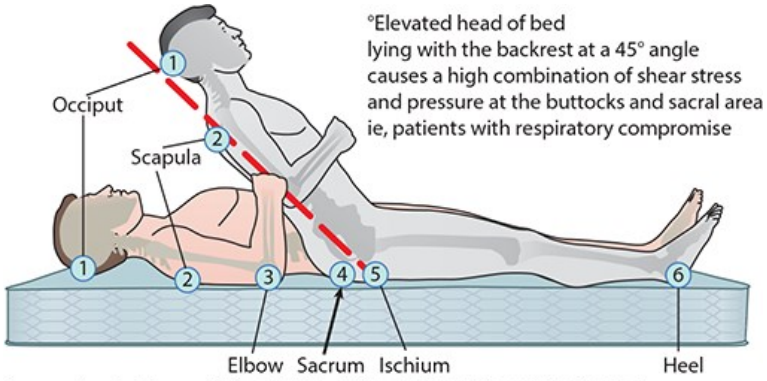


Shear forces act tangential to the tissue layers and distort both superficial and deep tissue, such as can occur as a patient slides down in bed. The force damages capillaries and leads to tissue anoxia and ultimately tissue necrosis. Shear forces causing deep tissue necrosis lead to undermining and sinus tracts in pressure wounds (**FIGURE 6-3**).

FIGURE 6-3

Shear



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The most common sites for the development of pressure injuries and ulcers are the sacrum, ischial tuberosities, trochanters, and heels; however, they can occur on any part of the body where there is unrelieved pressure between an external surface and a bony prominence for a prolonged period of time. The location of pressure injury risk changes whether the patient is lying supine or sitting. If the patient is supine, the most common sites will be the sacrum and heels, but in a seated position, the greatest pressure will be on the ischial tuberosities (**FIGURE 6-4**). The amount of time leading to destruction varies as described in **TABLE 6-1**. Reversal of tissue necrosis may or may not occur depending on the patient's clinical comorbidities and the healing potential. Skin ulceration is an open wound that occurs within 2 weeks of tissue necrosis.[9] There is an inverse time/pressure curve to skin necrosis, meaning the higher the amount of sustained, unrelieved pressure, the shorter the time frame in which tissue death can occur (**FIGURE 6-5**).[10]

FIGURE 6-4

Areas of the body at risk for pressure injuries By definition, pressure injuries and ulcers develop from mechanical forces applied over bony prominences where there is little or no soft tissue to dissipate the forces (friction, shear, or direct pressure). The most vulnerable areas depend upon the individual's body build.

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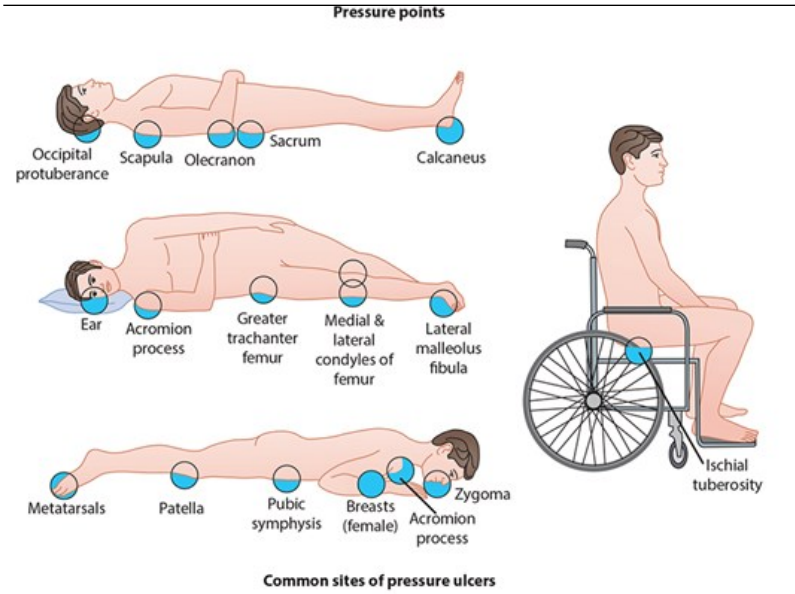

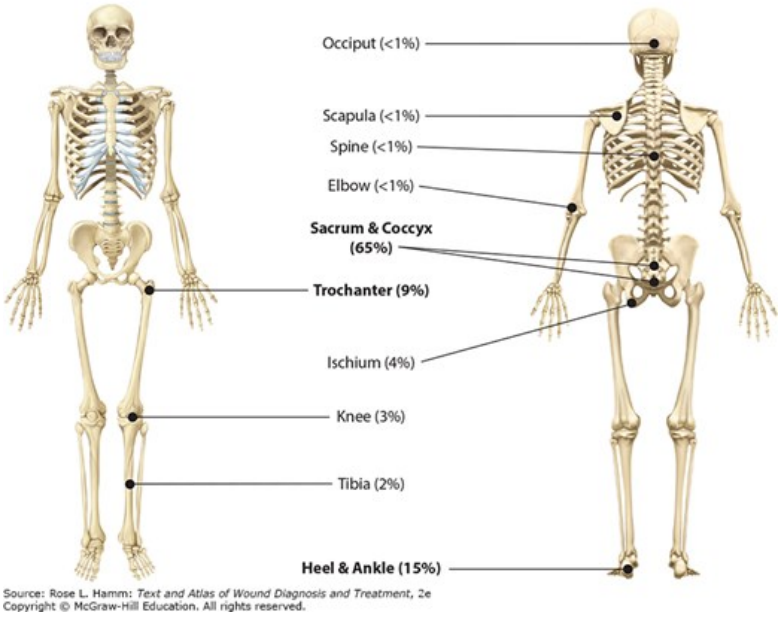

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FIGURE 6-5

Time/pressure curve for pressure ulcer formation Tissue damage can occur with prolonged exposure to low pressures or short exposure to high forces, depending on the body morphology, the surface, and the underlying comorbidities. Thus, care plans need to be individualized to the patient's medical status, body type, and risk factors.

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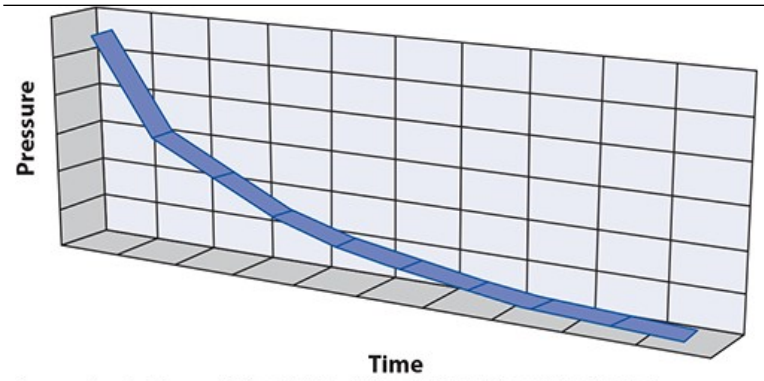

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TABLE 6-1

Time to Tissue Destruction

Tissue Damage	Definition	Time Frame	Time to Recovery
Tissue hyperemia	Blanchable erythema or redness	30 minutes	1 hour if pressure is relieved
Tissue ischemia	Deeper redness with damage of the underlying tissue	2–6 hours of unrelieved pressure	36 hours if pressure is relieved
Necrosis	Destruction of tissue	>6 hours of unrelieved pressure	Reversal of tissue necrosis may or may not occur depending on the patient's clinical comorbidities and their healing potential

Tissue damage is dependent upon the time and intensity of exposure to the mechanical forces, and recovery without ulceration varies according to the patient healing potential.[9]

Given that the highest rates of pressure ulcers occur on the sacrum, trochanters, and heels, it is estimated that 70% of pressure ulcers occur from the waist down. Healthcare professionals have an obligation to monitor patient skin and to implement a care plan to prevent pressure injuries and ulcers from occurring or to facilitate healing of any pressure ulcers a patient may develop. The purpose of this chapter is to educate the healthcare professional on prevention, assessment, and treatment of pressure injuries and ulcers.

PREVENTION

The prevention of pressure injury begins with a thorough assessment of the patient's skin. Once this is complete, *any lesions* (or lack of) of any etiology are documented in the medical record by the primary practitioner, be that the physician, the mid-level practitioner, or the physical therapist. The nurse or physical therapist can document and photograph the existing wounds, but the MD has to sign the documentation within 48 hours of admission. Not only is this good clinical practice, but as of October 2008, Center for Medicare and Medicaid Services (CMS) has linked payment of the higher Diagnostic Related Group (DRG) associated with pressure ulcers to this documentation.[11] An assessment tool for the risk of skin breakdown is advised both on admission and periodically thereafter. The most common and most validated scale used in the United States is the Braden scale (**TABLE 6-2**).

TABLE 6-2

Braden Scale for Predicting Pressure Sore Risk

PATIENT'S NAME _____ EVALUATOR'S NAME _____ DATE OF ASSESSMENT				

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SENSORY PERCEPTION Ability to respond meaningfully to pressure-related discomfort	**1. Completely Limited** Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of consciousness or sedation. OR Limited ability to feel pain over most of body.	**2. Very Limited** Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness. OR Has a sensory impairment, which limits the ability to feel pain or discomfort over half of body.	**3. Slightly Limited** Responds to verbal commands, but cannot always communicate discomfort or the need to be turned. OR Has some sensory impairment, which limits ability to feel pain or discomfort in one or two extremities.	**4. No Impairment** Responds to verbal commands. Has no sensory deficit, which would limit ability to feel or voice pain or discomfort.				
MOISTURE Degree to which skin is exposed to moisture	**1. Constantly Moist** Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.	**2. Very Moist** Skin is often, but not always, moist. Linen must be changed at least once a shift.	**3. Occasionally Moist** Skin is occasionally moist, requiring an extra linen change approximately once a day.	**4. Rarely Moist** Skin is usually dry, linen only requires changing at routine intervals.				
ACTIVITY Degree of physical activity	**1. Bedfast** Confined to bed.	**2. Chairfast** Ability to walk severely limited or nonexistent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	**3. Walks Occasionally** Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair.	**4. Walks Frequently** Walks outside room at least twice a day and inside room at least once every 2 hours during waking hours.				
MOBILITY Ability to change and control body position	**1. Completely Immobile** Does not make even slight changes in body or extremity position without assistance.	**2. Very Limited** Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.	**3. Slightly Limited** Makes frequent though slight changes in body or extremity position independently.	**4. No Limitation** Makes major and frequent changes in position without assistance.				
NUTRITION *Usual* food intake pattern	**1. Very Poor** Never eats a complete meal. Rarely eats more than one-third of any food offered. Eats two	**2. Probably Inadequate** Rarely eats a complete meal and generally eats only about half of	**3. Adequate** Eats over half of most meals. Eats a total of four servings of protein	**4. Excellent** Eats most of every meal. Never refuses a meal. Usually eats a				

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	servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement. OR Is NPO and/or maintained on clear liquids or IV's for more than 5 days.	any food offered. Protein intake includes only three servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR Receives less than optimum amount of liquid diet or tube feeding.	(meat, dairy products) per day. Occasionally will refuse a meal, but will usually take a supplement when offered. OR Is on a tube feeding or TPN regimen, which probably meets most of nutritional needs.	total of four or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.				
FRICTION AND SHEAR	**1. Problem** Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures, or agitation leads to almost constant friction.	**2. Potential Problem** Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against sheets, chair, restraints, or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.	**3. No Apparent Problem** Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.					
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This tool assesses six parameters, including activity, mobility, nutrition, sensory perception, moisture, and friction/shear. The highest possible score on the exam is 23; any score less than 18 is considered at risk. This scale, however, is not meant to replace clinical judgment. The assessment is also subject to change depending on the patient's medical condition; therefore, it needs to be rescored if changes in the clinical assessment occur. For example, when admitted to the hospital for an elective knee surgery, the patient is usually alert and oriented, able to toilet independently, has limited activity and mobility due to knee pain, but is eating well and has no issues with friction or shear. That patient would have a Braden score of 21 and would be considered at low risk for pressure ulcer development. If the patient has complications during surgery and cannot be weaned off of the ventilator, the medical status changes. The patient is now in an ICU setting, intubated, sedated, and incontinent, and therefore at moderate risk for friction/shear when being turned and repositioned. The nutrition is adequate because parenteral nutrition is initiated. This patient now has a Braden score of 10 and is considered at high risk for pressure ulcer formation.

Once risk is assessed, prevention strategies are implemented to minimize the risk of skin breakdown. The first of these strategies is turning and repositioning, which will be discussed in detail. Use of pressure redistribution surfaces for both the bed and the wheelchair will help reduce pressure on bony prominences. Another aspect of prevention is management of the medical factors that can put patients at higher risk for skin breakdown. Containment of urinary or fecal incontinence, protection of the skin with a moisture barrier or silicone-backed foam dressing,[12] assessment and maximization of the patient's nutrition, improved mobility, and proper management of underlying medical conditions such as diabetes mellitus and

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hypertension are several strategies that decrease the risk of skin breakdown.

INTERVENTIONS TO MANAGE TISSUE LOADING

As described above, both the magnitude and duration of tissue loading are important in the prevention of tissue damage. When a pressure injury or ulcer is present, managing the duration and magnitude of loading requires a greater level of attention and is accomplished by using bed support surfaces and wheelchair cushions. These devices are designed to redistribute pressures away from the primary load-bearing parts of the body that are the areas at highest risk for skin and subcutaneous tissue damage. Clinically, managing the duration of loading is accomplished with postural changes that redistribute loads away from tissues for periods of time (eg, with turning schedules for persons in bed and with weight-shifting activities for persons sitting in wheelchairs). In addition, some cushions and support surfaces can actively change their load redistribution properties to reduce the duration of loading.

Research has not defined a specific threshold for an acceptable magnitude of pressure on tissues. This is not surprising considering the variation in physiology and tissue biomechanics of people at risk for pressure injury. Without a clear mandate of acceptable loading on the tissues, clinicians are challenged to manage loads through interventions that must take into account ever-changing technology and the idiosyncrasies of any particular patient. Decisions about appropriate interventions can be facilitated by a working knowledge of support surfaces and positioning technologies, as well as the benefits and deficiencies of the different designs.

CASE STUDY

INTRODUCTION

Mrs. S is an 82-year-old frail white female with a history of diabetes mellitus (last hemoglobin A1c-8.0), hypertension, congestive heart failure with an ejection fraction of 35–40%, chronic kidney disease with a baseline creatinine of 2.1, atrial fibrillation on Coumadin therapy, and osteoporosis. Mrs. S lives alone in her own home and is able to do most of her activities of daily living without assistance. She is sometimes incontinent of urine, but is continent of bowels. She ambulates with a rolling walker. She was in her usual state of health until she sustained a fall in her home after slipping on a rug. She was able to call 911 and when paramedics arrived, she complained of right hip pain. She was taken to the ER for evaluation. Hip films revealed a right intertrochanteric fracture. The patient was evaluated by the orthopedic surgeon, but will require risk stratification prior to surgery due to her multiple comorbidities.

DISCUSSION QUESTIONS

1. What factors place this patient at risk for pressure ulcer development?
2. She is being admitted to the hospital. What strategies can be implemented to minimize her risk of skin breakdown?

Mrs. S was admitted to the surgical floor and put in Buck's traction until she could be cleared for surgery. She is placed on oxycodone/acetaminophen pain medication by the attending physician to help control her pain. She also has a zolpidem prescription for sleep. On day 2 of hospitalization, the patient is noted by her family to be confused. Because of the traction, she is now incontinent of bowel and bladder. The patient is noted to have redness on the right heel that is not blanching.

DISCUSSION QUESTIONS

1. What was the patient's Braden score on admission? What risk level did that make her?
2. What is the patient's Braden score at this point in the clinical history?
3. What additional factors have put this patient at higher risk for pressure ulcer formation?

Support Surfaces: Beds, Mattresses, and Overlays

Horizontal support surfaces (such as bed systems, mattresses, and overlays) play a large role in managing tissue loads, especially in the many

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environments where people are in bed for extended periods, are potentially immobile, and have comorbidities and/or injuries that weaken the body. Being comfortable with the terminology used to characterize and describe horizontal support surfaces is important for any clinician when reading research about this technology and when communicating with other professionals about appropriate interventions. The National Pressure Ulcer Advisory Panel (NPUAP) has developed a list of common terms and definitions for such purposes.[13] **TABLE 6-3** lists several categories and features of support surfaces and their respective definitions, and **FIGURES 6-6** to **6-9** illustrate some of the designs.

FIGURE 6-6

Cross-section of support surface A cross-section of a pressure-redistribution surface illustrates the combination of materials, construction, and air flow provided by an external pump. (From Hill-Rom® P500 Therapy Surface Mattress Replacement System, ©2019 Hill-Rom Services. Inc. Reprinted with permission. All rights reserved.)

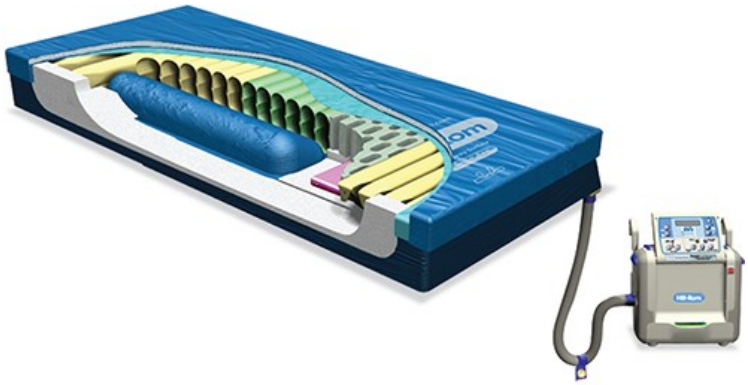

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FIGURE 6-7

Active support surface Air is circulated inside cells within the support surface to both immerse and envelope the patient and provide pressure redistribution. This type of powered mattress can be used on an existing bed frame. (From Envision® E700 Wound Surface, ©2019 Hill-Rom Services. Inc. Reprinted with permission. All rights reserved.)

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FIGURE 6-8

Alternating-pressure, low-air-loss support surface Alternating pressure is achieved by a pump blowing air through chambers to get rhythmic inflation and deflation and thereby redistribute the pressure. The air blowing through the cover reduces the skin/surface interface temperature and reduces the risk of maceration from moisture. Plastic bed liners should be avoided on these beds as the plastic obstructs the flow of the air and holds both heat and moisture against the patient's skin. (From Synergy® Air Elite Mattress Replacement System, ©2019 Hill-Rom Services. Inc. Reprinted with permission. All rights reserved.)

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FIGURE 6-9

Air-fluidized bed The air-fluidized bed, an integrated bed system, contains millions of silicone-covered beads that are continuously being blown by an air pump, thereby providing floatation to the patient. These beds are used for patients with multiple pressure ulcers, complex Stage III or Stage IV wounds, or postsurgical repair with a flap. (From Clinitron® II Air Fluidized Therapy Unit, ©2019 Hill-Rom Services. Inc. Reprinted with permission. All rights reserved.)

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TABLE 6-3

Categories and Features of Support Surfaces

CATEGORIES OF SUPPORT SURFACES	
Reactive support surface	A powered or non-powered support surface with the capability to change its load distribution properties only in response to applied load
Active support surface	A powered support surface with the capability to change its load distribution properties, with or without applied load
Non-powered	Any support surface not requiring or using external sources of energy for operation
Powered	Any support surface requiring or using external sources of energy for operation
Integrated bed system	A bed frame and support surface that are combined into a single unit whereby the surface is unable to function separately
Mattress	A support surface designed to be placed directly on the existing bed frame
Overlay	An additional support surface designed to be placed directly on top of an existing surface
FEATURES OF SUPPORT SURFACES	
Air fluidized	A feature of a support surface that provides pressure redistribution via a fluid-like medium created by forcing air through beads as characterized by immersion and envelopment
Alternating pressure	A feature of a support surface that provides pressure redistribution via cyclic changes in loading and unloading as characterized by frequency, duration, amplitude, and rate of change parameters
Lateral rotation	A feature of a support surface that provides rotation about a longitudinal axis as characterized by degree of patient turn, duration, and frequency
Low air loss	A feature of a support surface that provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin

Selection of the most appropriate support surface for the patient might be constrained by the hospital or care environment, but generally multiple options will exist. Informed decisions, of course, begin with an evaluation of the patient or client, but also must include basic knowledge of products.

Pressure ulcer risk evaluation is a natural place to start and is combined with assessment of function, including the patient's ability to reposition in bed and the ability to transfer into and out of bed. Differences in features and design form the basis of an informed clinical decision that is best made by the multidisciplinary team involved in the patient's care. Some support surface characteristics are technical in nature, such as the quality of component parts, warranty, expected lifespan, and maintenance requirements. For example, a support surface that requires periodic adjustment and maintenance may be appropriate in a facility with the capacity to handle those tasks, whereas it might not be a good choice in certain homecare environments, unless the patient and/or caregivers are comfortable in making those adjustments.

Support surfaces are designed to protect the skin and underlying tissues by allowing the patient to immerse or sink into the surface. Immersion redistributes pressures and envelops the body in an attempt to equalize external forces as much as possible. A support surface must be soft enough to allow immersion without bottoming out. Compliant support surfaces can deflect only so far before they cannot deflect further. This defines a “bottomed-out” state and results in high pressures on tissues. Because achieving an appropriate amount of immersion is so important, the optimal stiffness of the surface must take into account the patient morphology. A surface that is too firm will not allow the person to immerse, whereas one

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that is too soft might not afford a stable surface for functional mobility (eg, turning and moving in bed). Foam and gel materials generally have a fixed functional stiffness; thus, a surface with appropriate stiffness and thickness needs to be selected in order to provide the requisite support. Surfaces using air typically offer adjustability, thereby allowing functional stiffness to be appropriately adapted for each patient. In both cases, reevaluation after selection must be done to ensure that the support surface is properly configured to protect tissues and support the body.

Evaluating the Effectiveness of Support Surfaces

A large amount of research has focused on the effectiveness of support surfaces. Some use direct measures of clinical outcomes such as pressure ulcer incidence or time for pressure ulcers to heal. Others use indirect measures, including variables such as interface pressure, blood flow, and temperature. Both approaches have merit but report quite different information about support surface performance. An effective review of the literature requires an assessment of methodologies and devices with respect to how they apply to a particular situation. The patient population (eg, orthopedic neurological, geriatric), care environments (eg, ICU, homecare long-term care), and types of support surfaces may impact how results influence care decisions. Notably, treatment studies—in which subjects already have tissue damage—are fundamentally different from prevention studies. For the purpose of this chapter, a select number of comparisons are highlighted as a means to illustrate how studies are configured to investigate effectiveness. Several recent articles and documents have provided an overview of support surface research and can be referred to for more detailed information.[14–17]

Most studies compare different classes of products as defined in **TABLE 6-3** rather than compare similarly designed products. For example, many more studies compare a standard hospital mattress to a specialty mattress instead of comparing two different types of low-air-loss beds. Moreover, studies tend to focus on a specific model from one manufacturer. It would be impossible to study all makes and models that exist in a single support surface category. Any study involving technology has the potential to become outdated simply because technology changes. This does not mean that historical studies have no value; instead it acknowledges the challenge of focusing solely on published literature to make clinical decisions and highlights the need to keep abreast of this ever-changing body of knowledge.

The most common research comparison is against a “standard” hospital bed or mattress. Even though there are differences in what constitutes a standard hospital mattress, the results are clear: standard mattresses are not very effective to prevent or to treat pressure injuries and ulcers. Non-powered, constant-low-pressure support surfaces (foam, air, gel, and combinations of these materials) are more effective in preventing pressure injuries than a standard mattress.[14–16] In fact, standards of practice recognize this by mandating the use of alternative surfaces in the plans of care for persons who are at risk for or already have pressure damage.

Studies comparing advanced active technologies including low-air-loss, alternating-pressure, and fluidized surfaces tend to find them to be equivocal in effectiveness.[18–20] Evidence shows that these types of advanced support surfaces have roles to play in both prevention and treatment of pressure ulcers. Equivocal results should also motivate clinicians to read the literature in order to better understand the results and how the lack of significant results can also be clinically useful. For example, consider a comparison of two support surfaces in preventing pressure ulcers in the critically ill population.[9] Sixty-two persons were enrolled and nine of them developed pressure ulcers. The low incidence of pressure ulcers in this high-risk patient group resulted in an inability to detect differences in the two surfaces. Clearly, too few pressure ulcers are not a bad outcome, so the lack of a difference is still an important finding.

Protecting the Heels and Lower Extremities

For patients in bed, heels are particularly prone to pressure injury. This is not surprising if one reflects on the anatomy of the posterior aspect of the heel, the portion in contact with the support surface, and the amount of both direct pressure and friction that occurs at the heel (**FIGURE 6-2**). The calcaneus forms a small, narrow prominence that must bear the weight of the foot and part of the leg when the patient is supine. Even though the foot is a small mass, the small surface area results in damaging pressure. In fact, the heel is often cited as the second most common site for tissue damage, accounting for 25–30% of pressure ulcers.[21,22]

Many commercial devices and approaches are available to reduce or eliminate pressure on the heels. Mattresses and overlays are often designed to support the heels using softer materials or different designs than those used to support the rest of the body. Two additional types of devices are available: (1) user-worn boots or heel protectors, and (2) positioners to elevate the heels.

The user-worn approach consists of a boot or pad that encases the foot and heel and attaches directly to the person (**FIGURES 6-10** to **6-12**). These

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can be made from air bladders, foam, gel, or sheepskin materials. These devices remain in place during changes in position and as the legs move in bed; therefore, the fit and securement must be assessed. Most user-worn devices help prevent the ankle from plantar flexing (aka, foot drop) and some are designed to keep the ankle and foot aligned even in the presence of tone or spasm via the use of a rigid shell. If, however, the patient already has a plantar flexion contraction, the rigid support is contraindicated because peak pressures will occur at the plantar metatarsal heads and the Achilles tendons, causing pressure injury in these areas (**FIGURE 6-13**). Ambulation while wearing heel boots and pads is typically contraindicated (unless there is an ambulation sole attached); thus, these devices are not recommended when encouraging patients to transfer out of bed independently.

Many studies have documented interface pressure and other outcomes about various products. Reviews of these studies are often useful[23–26]; however, clinicians should read the primary source when using the results of a specific study to determine clinical decisions.

FIGURE 6-10

User-worn heel protector The Rooke boot is made of pliable sheepskin-like material that can be worn in bed and for limited ambulation. It is available with either a rigid frame to maintain ankle range of motion and without a frame to accommodate plantar flexion contractures.

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FIGURE 6-11

Rigid ankle-foot orthosis with heel relieved of any contact, both in supine and standing positions Many of these orthoses come with ambulating soles for safe weight bearing activities.

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FIGURE 6-12

Foam boots with suspended heels

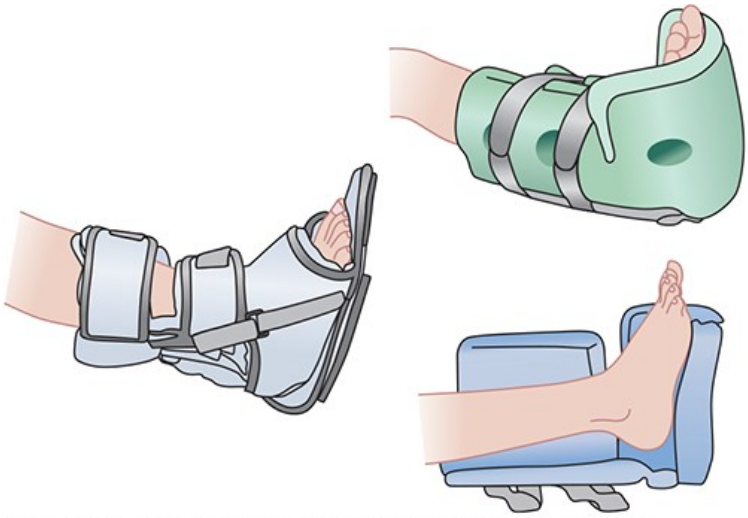

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FIGURE 6-13

Plantar flexed ankle A plantar flexed ankle that cannot be passively stretched to neutral placed in a rigid AFO will have peak pressures at the metatarsal heads and the Achilles tendon, thus putting these tissues at risk for pressure injury formation. Some AFOs have adjustable ankle joints to adapt to plantar flexion contractures.

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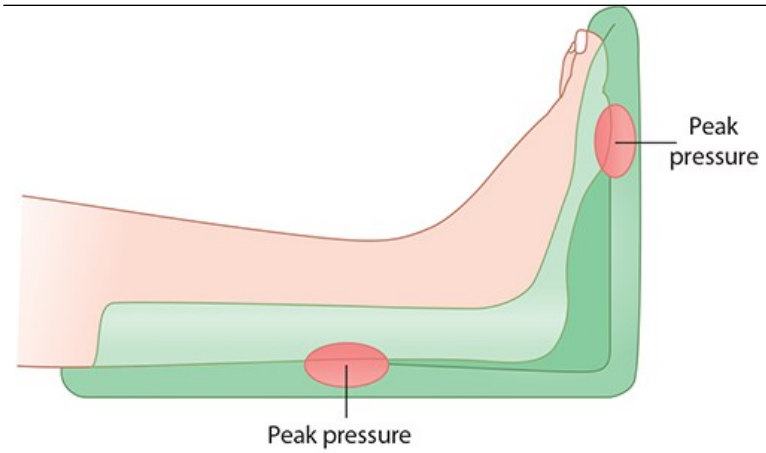

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The other category of heel protection is achieved by elevating (or floating) the heels completely off the surface by placing a positioning pad or pillow under the calf. Although some may extend to the knee, caution is advised with orthopedic patients when support under the knee may lead to knee flexion contractures (eg, after a total knee replacement). Several products can be purchased to provide heel elevation function (**FIGURE 6-14**) and are made from inflatable bladders or foam. Regular head pillows can be used to elevate the heels; however, they have been shown to be less effective because they compress and get out of position more easily (**FIGURE 6-15**).[16] Heel elevation devices do not necessarily accommodate changes in position and therefore must be assessed whenever a person returns to a supine posture or moves the legs. In addition, care must be taken not to elevate the foot in a manner that induces hyperextension at the knee, which will become uncomfortable. Any lower extremity positioning approach should be done after assessing ranges of motion at the hip, knees, and ankle to ensure that external positioners maintain appropriate joint positions.

FIGURE 6-14

Heel and foot elevating pad Pads under the calves are effective in off-loading or floating the heels; however, they may be displaced as the patient repositions. Care must be taken to avoid prolonged pressure on the posterior calf if the patient is insensate or atrophied (eg, a patient with spinal cord injury).

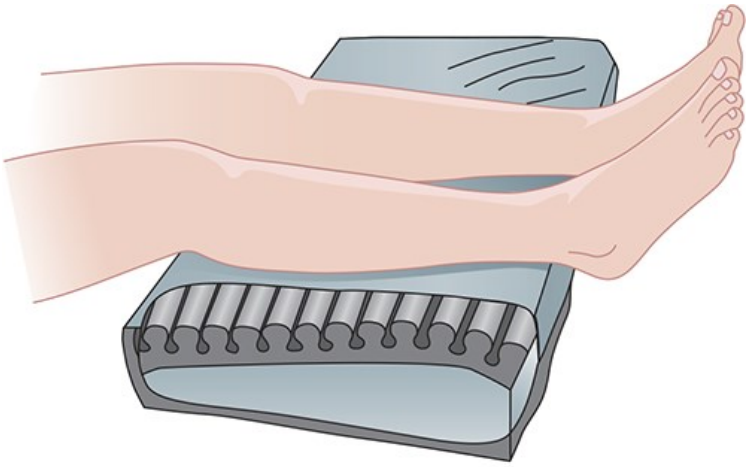

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FIGURE 6-15

Pillows used to off-load the heels When commercial devices are not available or not adaptable to a patient, pillows can be used creatively to accomplish pressure redistribution. This patient has bilateral foot drop and also tended to slide down in bed, putting the plantar metatarsal heads at risk. A pillow under the calves floats the heels and a folded pillow between the feet and the end of the bed off-loads the plantar surfaces. While improvisations may not be ideal, they can be effective for short-term care when combined with frequent repositioning.

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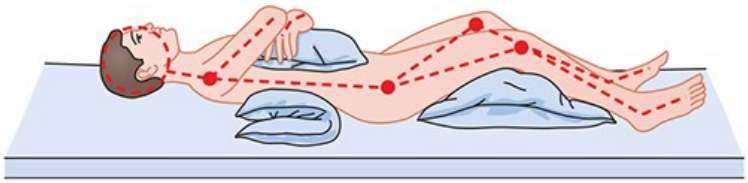
Positioning people in varying degrees of side-lying requires padding and positioners to ensure bony prominences are adequately protected (**FIGURE 6-16**). The malleoli and knees can be subjected to high pressures when in side-lying. These issues are discussed in the section on recumbent postures.

FIGURE 6-16

Thirty-degree side-lying posture Thirty-degree side-lying posture uses a foam wedge for positioning and pillows under the arms and legs and between the knees to protect bony prominences of all extremities and the sacrum. Folded pillows may be used behind the back and sacrum if foam wedge is not available. (Used with permission of Stephen Sprigle PT, PhD.)



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Wheelchairs and Wheelchair Cushions

People who use wheelchairs are as varied as people who ambulate. They exhibit a wide range of medical diagnoses, but share the functional limitation of being non-ambulatory or unable to ambulate functionally or safely. Because many wheelchair users sit throughout the day, many are at risk of developing pressure damage. Wheelchair users are assessed with respect to two common pressure-ulcer risk factors—immobility and sensation. Persons who are unable to recognize pain or discomfort while sitting are naturally at high risk for developing ulcers. Similarly, persons unable to move in their seat or to shift weight and self-correct posture are also at heightened risk. In both cases, these wheelchair users will be unable to recognize when damaging loads are placed on their skin and subcutaneous tissues.

Sitting-acquired pressure ulcers typically present at the load-bearing parts of the pelvis, specifically the ischial tuberosities and sacrum/coccyx (**FIGURE 6-17**). However, pressure ulcers can arise in other anatomical locations if the magnitude and duration of loading exceeds levels that the tissue can withstand. Other sites can be at risk in response to poor positioning within the wheelchair, including the scapular region, head, lateral trunk, knees, and feet. Therefore, proper positioning and body support are important in the prevention and management of tissue damage.

FIGURE 6-17

Vulnerable areas when patient is sitting in wheelchair The most vulnerable areas for skin breakdown when a patient is sitting in a wheelchair include the ischial tuberosities, sacrum, coccyx, scapula, head (when using high-back chairs), lateral trunk, knees, and feet. (Used with permission

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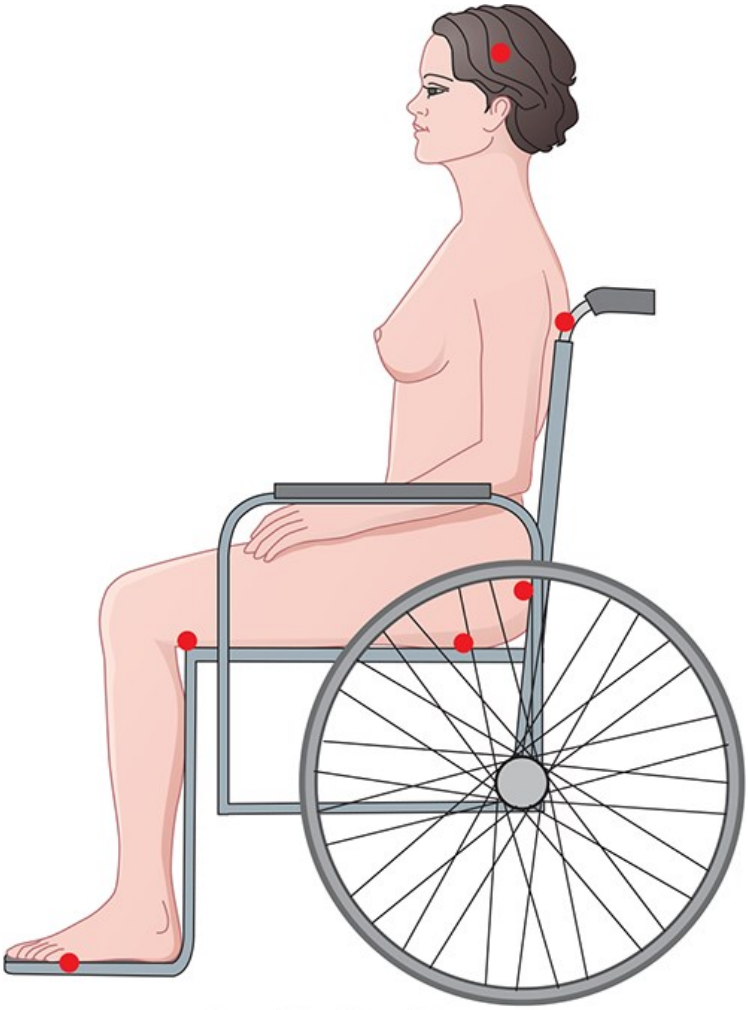
from Powers JG, Odo L, Phillips TJ. Decubitus (pressure) ulcers. In: Goldsmith LA, Katz SI, Gilchrest BA, Paller AS, Leffell DJ, Wolff K, eds. *Fitzpatrick's Dermatology in General Medicine*. 8th ed. New York, NY: McGraw-Hill; 2012:chap. 100. Available at: https://accessmedicine-mhmedical-com.ezproxy.cihe.edu.hk/content.aspx?bookid=392&sectionid=41138687. Accessed December 28, 2018.)



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Wheelchair Positioning and Fitting

Wheelchairs are not a one-size-fits-all piece of equipment. Because wheelchairs are functional devices, wheelchair users are assessed from both functional and medical perspectives. Proper fit of the wheelchair to the individual is of utmost importance.

Several common problems arise when a wheelchair is poorly fitted to the wheelchair user. These include:

- Sliding out of chair
- Poor sitting tolerance
- Lateral trunk instability
- Poor thigh/foot stability
- Inability to reach the ground to propel
- Inability to hand propel effectively

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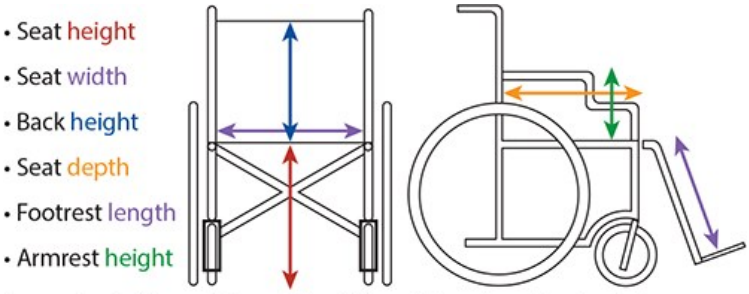
These problems result in an increased risk of skin breakdown because postural problems due to inadequate body support result in high pressures at areas of bony prominences. For example, a poorly fitted wheelchair seat can encourage a person to slide forward on the seat. This results in the pelvis rotating posteriorly and exposes the sacrum and coccyx to unnecessary loading. Lateral trunk instability can result in a person leaning against the backrest upright, which results in a pelvic obliquity that elevates pressure on one ischial tuberosity and can cause high localized pressure on the lateral trunk.

Six wheelchair measurements are considered when configuring a wheelchair to a person: seat height, seat width, seat depth, backrest height, footrest height, and armrest height (**FIGURE 6-18**). Seat height, seat width, seat depth, and backrest height are dimensions that are usually selected when ordering a wheelchair. Conversely, footrest height can be adjusted on nearly all wheelchairs, and most chairs permit armrest height adjustment. These features can, therefore, be matched to the individual during the fitting process.

FIGURE 6-18

Wheelchair dimensions to consider when fitting a chair for the individual (Used with permission from WoundZoom, Inc.)



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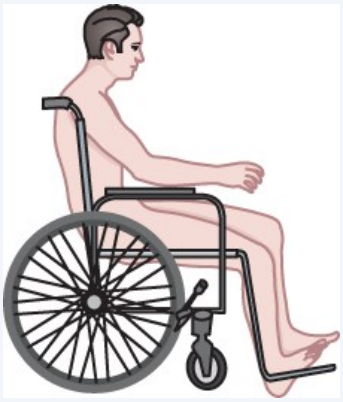
A poorly fitting wheelchair has a detrimental impact on posture, thereby resulting in decreased function and increased loading on the buttocks. A slouched kyphotic posture is the most common poor posture resulting from an inadequate wheelchair and seating system. This posture is characterized by a posterior pelvic tilt and kyphotic spine. A slouched posture elevates pressure at the sacrum and coccyx and the resulting increased forward sliding tendency exposes the tissues to friction and shear strain. **TABLE 6-4** lists some common postural impacts of a poorly fitted wheelchair.

TABLE 6-4

Common Postural Changes in a Poorly Fitting Wheelchair

Poor Wheelchair Fit		Postural Impact
Seat too high		For someone who propels with one or both feet, a high seat height will encourage sliding forward on the seat in order to reach the ground. This results in a slouched posture and further increases the tendency to slide forward.

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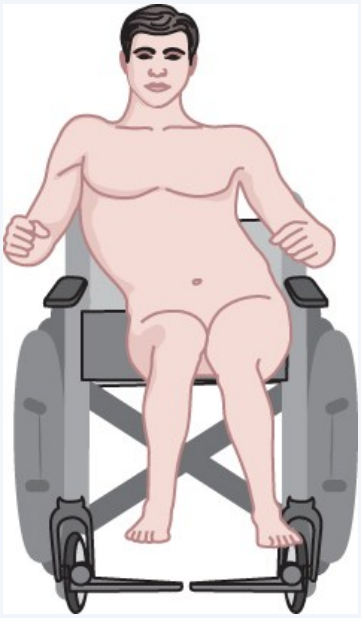
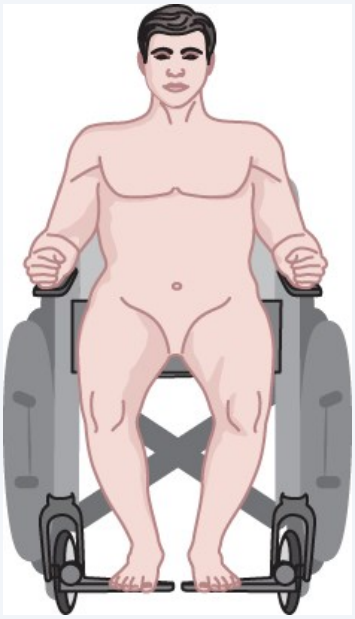
Seat too low or footrest too high		Knees are elevated and thighs rise off seat surface, leading to increased loading on the buttocks and ischial tuberosities and poor lower limb stability.
Seat too wide		Leaning to use armrests induces a pelvic obliquity and increases pressure on the ischial tuberosity; an unnecessarily wide wheelchair leads to poor access to handrims and reduced maneuverability.
Seat too narrow		The chair is difficult to transfer into; contact with armrests or clothing guards increases pressures on lateral tissues.

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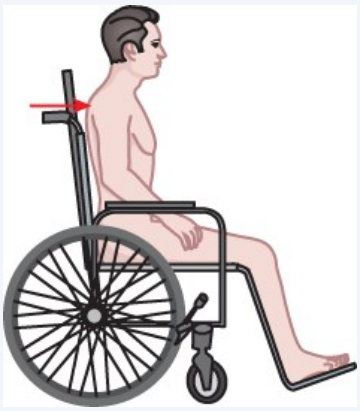
Seat depth too long		Contact at popliteal region encourages a person to slide forward into a slouched posture that thereby increases sliding tendency and elevates sacral/coccyx pressure.
Seat depth too short		Inadequate thigh contact decreases postural stability, resulting in sliding forward into a slouched posture; poor lower limb stability can lead to external or internal rotation at the hips.
Backrest height too low		Inadequate trunk stability can result in a person seeking support by leaning to one side, which results in a pelvic obliquity or sliding forward into a slouched, kyphotic posture.
Backrest height too high		A backrest that is too high increases loading at the scapula and pushes the upper trunk forward; this can lead to a person sliding into a kyphotic, slouched posture; a high backrest can also hinder upper extremity reach.

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Wheelchair Cushions

Wheelchair cushions are required for all wheelchair users because wheelchair seat upholstery is simply not designed or intended to offer adequate support. The selection of wheelchair cushions for persons identified to be at risk of pressure ulcers is obviously more involved and requires more attention than selection of a cushion for a person with intact sensation and adequate mobility who uses a wheelchair for only short durations of time. Many wheelchair users sit in their wheelchairs throughout the day, sometimes for 12 hours or more.[23,25]

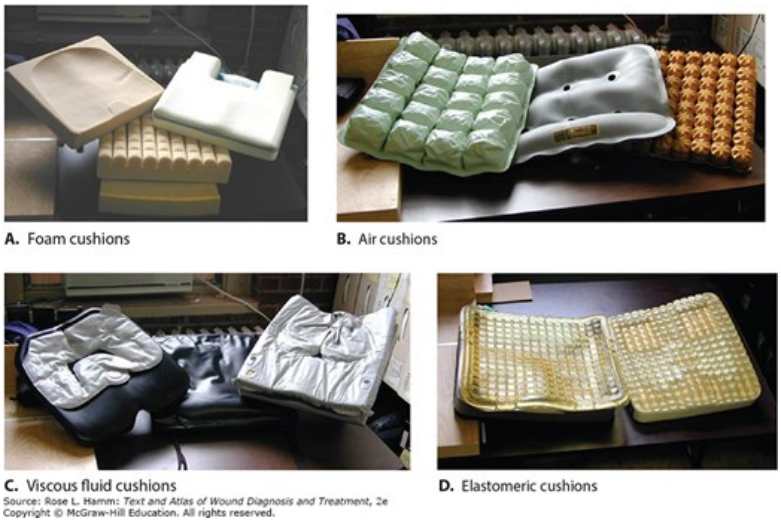
Hundreds of cushions are commercially available, so many options exist for both full-time and part-time wheelchair users. A basic understanding of materials, design, and performance can assist the clinician in selecting appropriate cushions for wheelchair users. The two most important things to remember are: (1) no one cushion is best for all people, and (2) cushion selection must reflect the needs, function, and activities of the wheelchair user. The second point highlights the fact that cushions serve other roles besides managing loads on tissues. Cushions impact many aspects of functioning during everyday activities, including posture, comfort, transfers, heat and moisture of the cushion interface, and a host of other factors. In addition, the environment of use, amount of use, and activity level of the user influence cushion selection. A person who sits in a wheelchair for 16 hours a day and travels outdoors over a variety of surfaces has different needs than a person who sits in a wheelchair for 2 hours per day because he or she transfers into other chairs and surfaces. Clinicians use their skills to evaluate their clients and patients in order to select an appropriate cushion. Therefore, combining the functional impact of cushions with requirements to promote skin health is the appropriate approach.

Most wheelchair cushions can be described as reactive and non-powered. Although a few powered, active cushions do exist, they are not commonly used except in complex situations (eg, a person with a history of multiple pressure ulcers). Cushions can be flat or contoured, and are designed to deform and deflect to accommodate the buttocks.

Wheelchair cushions are made from a variety of materials and reflect many designs, although four materials dominate: foam, air, viscous fluid, and elastomers. Foam cushions are the most common; however, most advanced cushion designs use a combination of materials with the intent of maximizing cushion performance by managing the good and poor features of each material. **TABLE 6-5** lists these common materials, some of the beneficial features, and their limitations. **FIGURE 6-19** illustrates the myriad cushions fabricated with different materials. Functionally, cushions can be categorized by their skin protection and positioning capabilities. In the United States, these categories are often used by insurance companies and other third-party payers. Although many cushions are designed to provide both functionalities, the following sections discuss the rationale behind these general categories.

FIGURE 6-19

Wheelchair cushions Designs of wheelchair cushions highlighting various materials of construction. (Used with permission, Stephen Sprigle, PT, PhD.)



A. Foam cushions

B. Air cushions

C. Viscous fluid cushions

D. Elastomeric cushions

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TABLE 6-5

Common Materials Used in Cushion Construction

Material	Benefits and Reasons for Use	Drawbacks
Foam	Inexpensive; comes in many stiffnesses, can be carved, cut, and molded easily; lightweight; good resilience and damping properties.	Heat insulator, so entraps body heat; needs to be protected from light and moisture; can have short lifespan.
Air	Lightweight; offers adjustability; good impact, damping, and resilience.	Impermeable bladder impacts cushion mass, can hinder effectiveness and heat management; inflation needs to be checked regularly; can be punctured.
Viscous fluid	Displaces in response to load to envelop the buttocks; some fluids provide heat transmissibility.	Can be heavy; poor resilience and impact damping; creep over time can reduce performance; its impermeable bladder can hinder effectiveness and heat management; nonadjustable.
Elastomer	Used as a top layer to envelop the buttocks and dissipate heat.	Can be heavy and expensive; incompressible, so must be used with other materials to fully envelop; poor impact damping; can creep over time.

Skin Protection Cushions

Cushions designed for skin protection target loading on the skin, as well as adequately managing temperature and moisture at the buttock-cushion interface. In addition, they offer a stable base of support. In the seated posture, loading on the buttocks represents the greatest risk for tissue damage. Cushions attempt to redistribute pressures away from bony prominences such as the ischial tuberosities and sacrum/coccyx. Two general techniques are followed: (1) envelopment and (2) redirection or off-loading.

Envelopment is defined as the capability of a support surface in deforming around and encompassing the contour of the human body.[27] In order to properly envelop, cushions must deflect and deform to immerse the buttocks in the material. Due to the design of the pelvis, about 4 cm of immersion is needed to adequately encompass the buttocks. This is based on the inferior position of the ischial tuberosities during sitting (**FIGURE 6-20**). As a result, cushions need adequate thickness to permit that amount of immersion. Foam cushions that are only 5 cm (2") thick will probably not suffice as skin protection cushions.

FIGURE 6-20

Anatomic relationship between the inferior aspects of the ischial tuberosity and greater trochanter (Used with permission, Stephen Sprigle, PT, PhD.)

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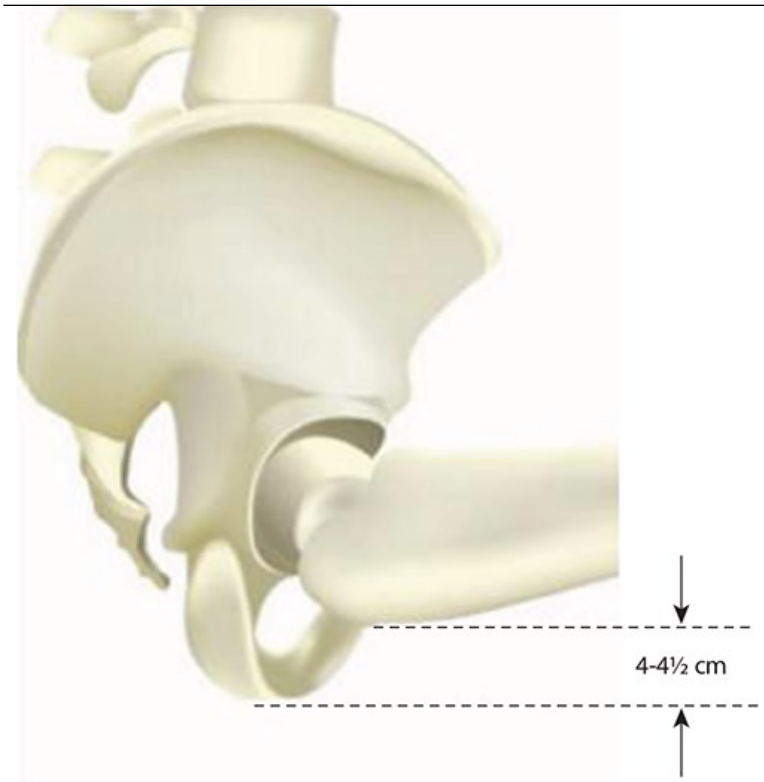

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Some cushions are designed to purposely redirect forces away from bony prominences using cutouts or contours in the cushion surface (**FIGURE 6-21**). As a result, cushions with cutouts and contours require the person to sit on the cushion in a specific location; therefore, proper training and instruction should be an integral part of any cushion fitting session.

FIGURE 6-21

Cushions with cutout or reliefs to redirect loading Cushions with cutouts are frequently custom-made to fit the patient's anatomical dimensions. Because shifting weight in the cushions will change the pressure points, appropriate training and use are required for optimal efficacy.

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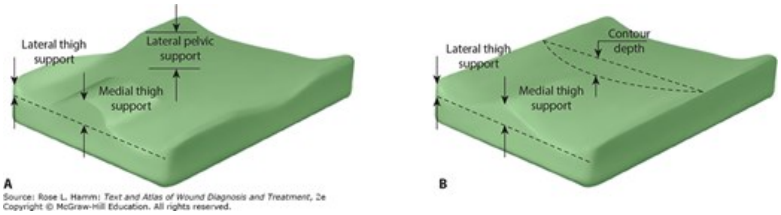
Positioning Cushions

Postural support is an important factor in cushion selection, just as it is in wheelchair fitting, because cushions are important in facilitating seated functional activities. Positioning can be grossly categorized as alignment, accommodation, or correction; a clinician performs an evaluation to determine which kind of positioning is needed. To properly *align* the body in an erect and symmetric posture, cushions may include certain features such as contouring for the buttocks, lateral pelvic supports, and lateral and/or medial thigh supports (**FIGURE 6-22**). Appropriate cushions do not promote a slouched posture and prevent the buttocks from sliding forward in the seat. Clients who sit with a fixed asymmetry (such as a pelvic obliquity) require a cushion that can *accommodate* a deformity. These cushions often include some adjustable feature, such as adding or removing components or altering the air inflation level. Conversely, if an asymmetry is *correctable*, a cushion can be used to position a client into a symmetric posture by the same means and thereby correct the faulty posture. Evaluation (including ROM, tone, and functional assessment) is needed to determine which type of positioning is optimal for the patient.

FIGURE 6-22

Flat (**A**) and contoured (**B**) cushions with positioning features. (Used with permission from Stephen Sprigle, PT, PhD, © Georgia Tech Research Corporation, Atlanta, GA.)



Positioning features of cushions typically result in a cushion surface that is site specific, meaning that the user must sit on the cushion correctly. For example, sitting too forward on a cushion may result in the person sitting on the medial thigh support or pommel. Cushions with deep contours or pronounced positioning features are designed to provide a very stable sitting surface; however, these characteristics may also impede function. For example, a contoured cushion with a pommel may be needed to position the lower extremities, but it can also impede transfers if the person cannot overcome this positioning feature. This again underscores the importance of a proper assessment because all cushions will have benefits and deficiencies that must be reconciled for each individual user.

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In summary, many wheelchair cushions are commercially available. Having myriad choices can empower clinicians and clients, but selection can also be confusing. By reflecting upon the seating goals for the patient or client and the various cushion materials and designs available, an informed decision can be made.

INTERVENTIONS TO REDUCE DURATION OF LOADING

The motor and sensory systems are responsible for ensuring that the body can move periodically to change posture. An individual responds to discomfort, often subconsciously, with small movements, postural shifts, or fidgeting. Research on sitting and comfort[28–31] has led to the understanding that sitting is a dynamic activity. Many people at risk of developing pressure ulcers either are unable to effectively reposition themselves or do not have the sensory feedback to elicit movement. Therefore, the losses of mobility and sensation are identified as risk factors within every pressure ulcer risk assessment scale. This information is used to target movement as a means to redistribute pressure and alter the duration of loading on tissues via turning schedules while in bed and weight-shifting strategies while seated.

Recumbent Postures

Positioning in bed has significant influence on tissue health. Because some people spend long continuous hours in bed, tissues can be exposed to pressures, temperatures, and humidity that can lead to tissue necrosis or prevent tissues from healing properly. The first clinical objective of recumbent positioning is to support the body in a safe, stable, and functional manner. This requires an assessment of body alignment, joint angles, and weight-bearing surfaces in various postures that are commonly adopted by patients in bed. No single recumbent posture can be maintained for long durations. As noted below, each posture has both benefits and drawbacks, so, typically, though not always, patients are sequenced through postures over time.

Supine

The supine position can be considered the default recumbent posture, and for good reasons. Supine positioning offers the patient an opportunity to interact with other people and the environment, to perform in-bed functional tasks, and to be accessible for and participate in clinical care. However, supine positioning also exposes certain anatomical sites to potentially harmful tissue loading. The sacrum and the heels are the two most common sites for pressure ulcer development and both sites are loaded in supine. Other posterior structures such as the occiput, scapula, and iliac crests can also be exposed to elevated pressures in the supine position.

Pillows, positioning devices, articulating bed frames, and support surfaces are used in combination to support and position the body. Therefore, these factors are considered when assessing the supine positioning of a patient.

Pillows are used to support the head, but, in excess, can put the cervical and thoracic vertebrae into too much flexion and result in discomfort. If the patient is on a ventilator or has a nasogastric feeding tube, pillows under the head and neck need careful monitoring so that function of the equipment is not interrupted. Bed articulation can be used to slightly raise the head and trunk as a substitute for using multiple pillows; however, elevating the head of the bed has potential detriments which are discussed below.

The bed and supporting surface should accommodate the patient's asymmetries and postural deformities, not the other way around. Assessing ranges of motion of the trunk, hips, and lower extremities provides information needed to select positioning devices to accommodate fixed deformities and promote stable posture. For example, the presence of a knee flexion contracture can be accommodated by proper placement of a foam positioner, pillow, or bed frame adjustment fitted to the knee range of motion.

Because the supine position exposes several anatomical sites to potentially harmful pressures, changes in position are necessary. Semi-reclined and side-lying postures are two common alternative postures, but each has drawbacks from a pressure loading perspective. Nonetheless, these drawbacks can be minimized by following certain guidelines and understanding the biomechanics of these postures.

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CLINICAL CONSIDERATION

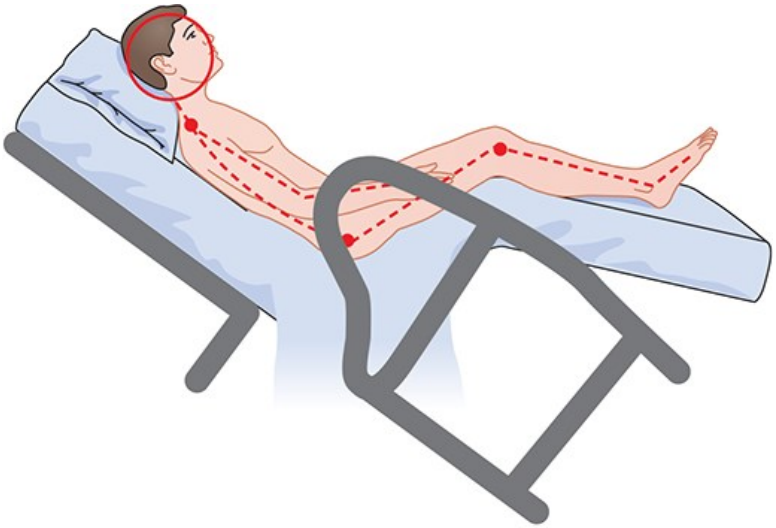
Pressures on the popliteal fossa must be minimized to prevent compression of the neurovascular structures that can lead to pain, paresthesia, and circulation impingement. Pillows under the knees of a patient who has had a total knee replacement may result in a slight knee flexion contracture and alter the gait pattern.

Reclined Positions

A semi-reclined position, sometimes referred to as Fowler's position, results from elevating the head of the bed (**FIGURE 6-23**). Elevating the head is done to facilitate eating, reading, interacting with visitors, and many other functional activities. This posture, however, also changes the loading on the body, which has resulted in the common practice of limiting head of bed elevation to 30° or less in order to prevent friction and shear. Principles of physics dictate that any elevation will increase the tendency for the patient to slide down in the bed (**FIGURE 6-18**). Upper-body weight is projected downward due to gravity and the inclined bed results in some forces being normal to the bed surface and some projecting tangentially. This tangential force results in a tendency to slide downward and may produce friction on the skin. As noted above, friction can be damaging to the tissues by causing abrasion and blistering.

FIGURE 6-23

Semi-reclined or Fowler's position Raising the knee portion of the bed frame will counteract sliding tendency but can expose the sacrum to higher loading.



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If the body weight moves downward and the skin remains in place on the bed surface, shear forces occur between the sacrum and the adjacent soft tissue, resulting in capillary damage, bleeding into the tissues, and a resulting inflammatory response and tissue necrosis. This shear strain and subsequent tissue loss is the pathophysiology of deep sinus and undermining formation, deep tissue injury, and eventual Stage III and IV sacral pressure ulcers. (See **FIGURE 6-3**.)

Despite the common practice of limiting head of bed elevation to 30°, there is no minimum threshold for this tangential force. The greater the angle of the bed, the greater the sliding tendency. Therefore, the impact of head of bed elevation must be evaluated for each patient. If a patient continually slides downward and must be moved back into position, then elevation is too great. Strategies to counteract the sliding tendency include gatching the bedframe at the hips by elevating the knee portion of the bed frame (**FIGURE 6-24**). Before elevating or gatching the head and knee portions of the bed, the hips must be in line with the hinge of the bedframe to allow the body to flex appropriately.

FIGURE 6-24

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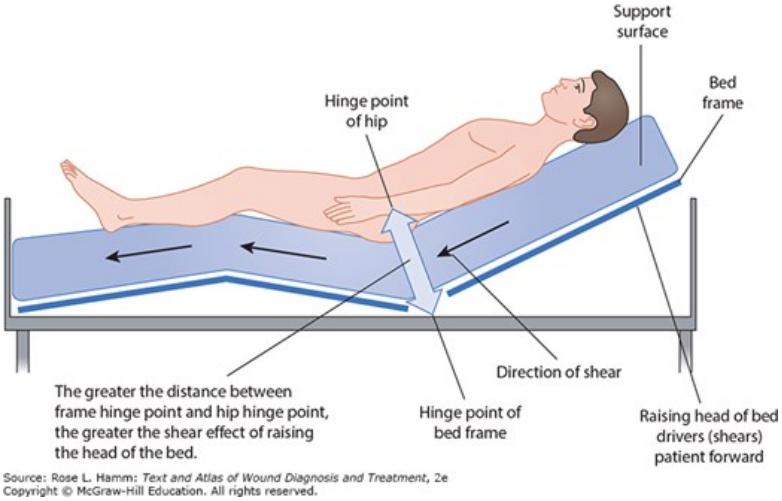
Position of patient in bed to prevent sliding Aligning the hips with the joint angle of the bed will assist in preventing sliding, which causes both friction and shear forces of the sacral area. Note the slight gatching of the bed at the knees as well. When repositioning the patient in bed, gatching the knees *before* raising the head is another strategy to prevent sliding.


Support surface
Bed frame
Hinge point of hip
Direction of shear
The greater the distance between frame hinge point and hip hinge point, the greater the shear effect of raising the head of the bed.
Hinge point of bed frame
Raising head of bed drivers (shears) patient forward

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This position, however, raises the second issue of a semi-reclined position. A valley is created when the head and knee are raised, which results in greater body weight being borne at the lower back and sacrum. Therefore, just like any position, a semi-reclined position should not be maintained for long durations. The key to proper bed positioning is to vary the postures so that loading is continually redistributed to different parts of the body.

CLINICAL CONSIDERATION

Note that while keeping the head of the bed less than 30° is advisable for prevention of pressure ulcers, there are certain medical conditions that require the head be elevated 30° or more (eg, if the patient has a nasogastric tube), and in those situations the medical concern must take precedence.

Side-Lying Positions

The need to relieve pressure from the sacrum, scapula, and other posterior bony prominences requires the use of varying degrees of side-lying. The most common side-lying posture rotates the trunk and pelvis 30° with respect to the horizontal support surface. This posture can eliminate pressures on the sacrum while avoiding the high pressures on the trochanters and iliac crests that tend to occur in a full 90° side-lying posture. External supports are needed to maintain the body in a 30° side-lying posture. Foam wedges are typically more effective than pillows because they provide more stable support (**FIGURE 6-16**). The wedge is positioned to support the trunk and shoulders and can be placed to totally relieve pressure on the sacrum. In addition, the knees and ankles must be separated with pillows or padding to protect the bony prominences. Finally, a pillow under the upper arm helps maintain the shoulder in a comfortable and stable position.

Turning Frequency

Manual repositioning has been cited as the most commonly used turning strategy and also as the most expensive.[32] The need for repositioning has been cited in literature and textbooks since 1800s,[33] and evidence that some repositioning is necessary can be found across decades of literature.

In the United States, common practice requires that at-risk patients are repositioned at least every 2 hours “if consistent with overall patient goals.”[34] The origins of this practice remain unclear and it has been adopted despite the lack of strong scientific evidence.[33,35,36] Nonetheless, the need for repositioning is corroborated by all the research that identifies duration of loading as a causative factor in pressure ulcer occurrence.

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CLINICAL CONSIDERATION

Turning schedules are not the same for every patient. Small, cachectic, hypotensive patients require turning more frequently than every two hours. Turning schedules need to be individualized based on risk factors for pressure ulcer formation, body type, and support surface.

The vast differences in patients, amount and type of tissues overlying bony prominences, and performance of support surfaces demand that the required frequency of turning is not the same for every individual. The clinical challenge lies in the fact that not turning frequently enough has worse consequences compared to turning too frequently. Some research has investigated the influence of the support surface in determining the optimal turning schedule. deFloor et al. showed pressure ulcer outcomes of patients lying on a standard mattress with 2- and 3-hour turning schedules were similar to the outcomes of patients lying on a viscoelastic mattress with a 6-hour turning schedule. These researchers also found that turning every 4 hours when using a viscoelastic mattress significantly reduced Stage II pressure ulcer incidence.[37]

Other research suggests that turning may need to occur more frequently than every 2 hours, and that sufficient pressure reduction surfaces are needed in addition to turning.[35,37–39] A recent study by Vanderwee et al.[39] found no differences in pressure ulcer occurrences between patients repositioned every 4 hours and those positioned for 2 hours in side-lying and 4 hours in supine. Furthermore, these authors confirmed a readily accepted clinical situation—patients who are able to reposition in bed will do so. On one hand, functional movement in bed should be promoted because it sequences the person through different postures. However, if independent repositioning involves a return to supine with no subsequent changes in position, additional intervention may be needed to ensure adequate turning frequency.

Wheelchair Weight Shifts and Pressure Reliefs

The need to reduce the duration of loading is just as important in sitting as it is when lying in bed. Thus, during rehabilitation, wheelchair users are taught preventative weight shifts or pressure reliefs in order to relieve pressure from the buttocks and thereby minimize the potential for skin breakdown. Guidelines have been published recommending frequency of weight-shift activities,[30–32] with a primary focus on persons with spinal cord injury; however, these principles can be applied to all wheelchair users. The guidelines vary considerably and recommend that persons perform pressure reliefs every 15, 30, or 60 minutes. They also suggest that the duration of the pressure relief should last 15–30 seconds up to a full minute.[40–42] Based upon the wide range of these guidelines, one can infer that they were based upon a combination of clinical experience, clinical insight, and research findings. Therefore, clinicians need to work with their clients to define a routine to which the patient will adhere.

Weight-shifting will be more easily adopted as a routine if taught as a relatively frequent activity as opposed to a less frequent one. One compromise might be to train wheelchair users to perform weight shifts every 30 minutes with 30-second duration. However, the most important goal should be to devise a plan that is attainable for the individual. Wheelchair users will not benefit by being instructed to perform activities that they cannot functionally manage.

Three common weight-shift options are a lift, forward lean, and side-to-side weight shift. A lift has the benefit of completely off-loading the buttocks, but it is also the hardest to perform from a functional standpoint (**FIGURE 6-25**). Not all persons can generate the forces or have the postural control necessary to perform this maneuver. A forward lean is performed by shifting the trunk as far forward as possible (**FIGURE 6-26**). Although some people have the flexibility to flex the trunk all the way to the thighs, this is not possible for many wheelchair users, so a lesser lean can also be used. By resting the elbows on the knees, buttocks loading can be reduced (**FIGURE 6-27**). Proper training is imperative because a small forward lean will not be sufficient. Side leans can also be effective, and wheelchair users can be taught to hook around the armrest or grab the drive wheels to maintain balance (**FIGURE 6-28**). Naturally, a side lean to one side must be followed by one to the opposite side to ensure the entire buttock surface is unweighted.

FIGURE 6-25

Lift pressure relief The lift pressure relief requires that the individual have sufficient upper extremity strength to lift the buttocks off the chair and maintain the position for at least 30 seconds. This not only relieves the pressure but also allows reperfusion of any tissue that has been compressed.

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FIGURE 6-26

Full-forward lean to accomplish weight shift

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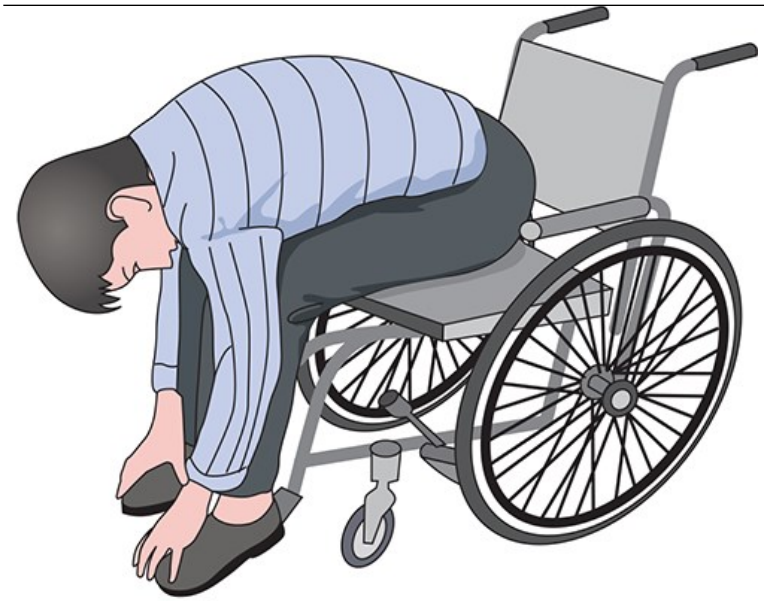

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FIGURE 6-27

Partial forward lean Lesser weight reduction is achieved by leaning forward with the elbows on the knees, thereby taking some of the weight off the sacrum and ischial tuberosities. (Used with permission from Stephen Sprigle, PT, PhD.)

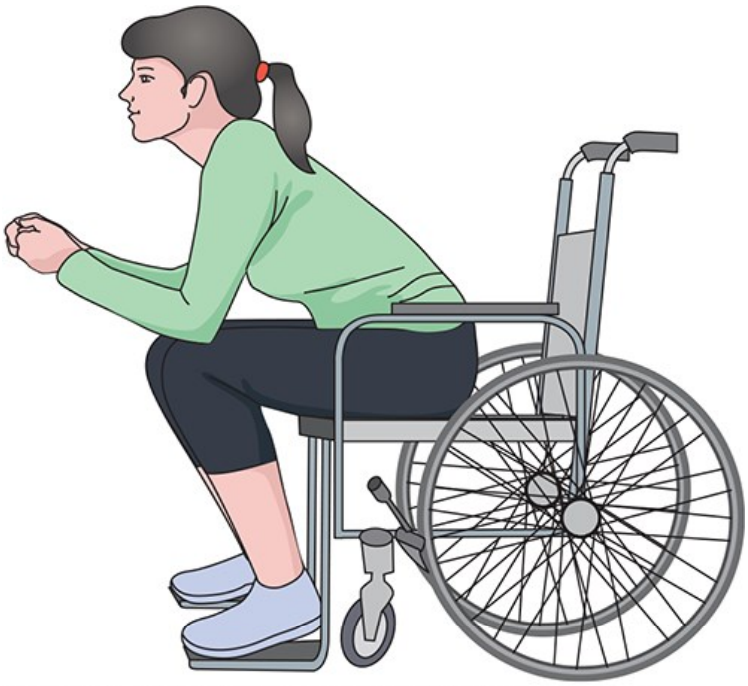

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FIGURE 6-28

Partial weight shifts

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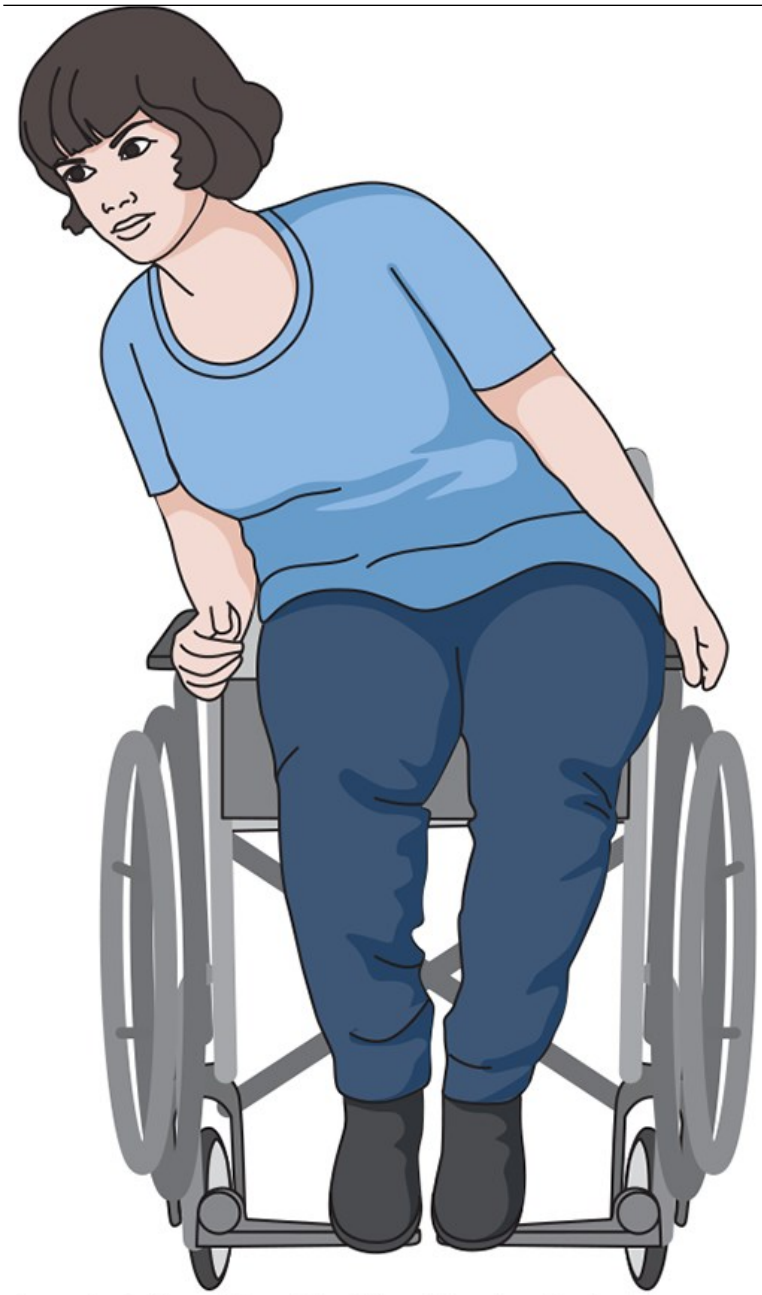

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DOCUMENTATION

Despite the interventions put in place to prevent pressure injury and ulcer development, skin breakdown can occur. As with any other organ system, documentation of a normal or abnormal exam of the skin is a routine part of the physical exam. It is routine in a patient care note to document systems (such as cardiovascular, respiratory, and gastroenterology), but the skin exam has not been a regular component in the documentation of the physical exam. If skin breakdown is present, thorough documentation requires a number of components, including anatomic location, pressure ulcer stage, size (length × width × depth in cm), character of the tissue in the wound, description of the periwound skin, type and amount of drainage, and finally, the presence of undermining or tunneling. (Refer to Chapter 3, Examination and Evaluation of the Patient with a Wound, for a more detailed discussion of wound assessment and description.) **TABLES 6-6** and **6-7** are provided to aid in the visual assessment of pressure ulcers. The elements of this documentation can create a clinical picture of the wound appearance; however, a photograph is also advised. The documentation also serves as a means of communication with the healthcare team and allows the provider to determine whether the wound is improving. Additionally, as per CMS

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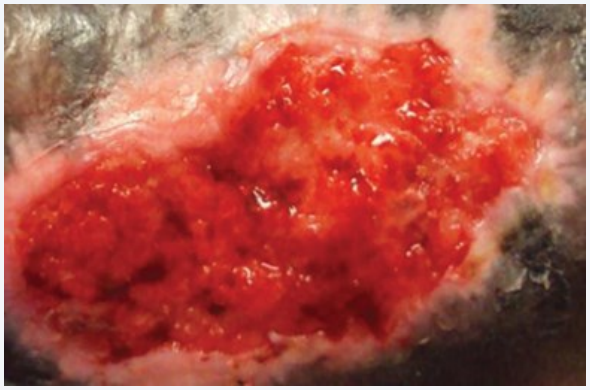
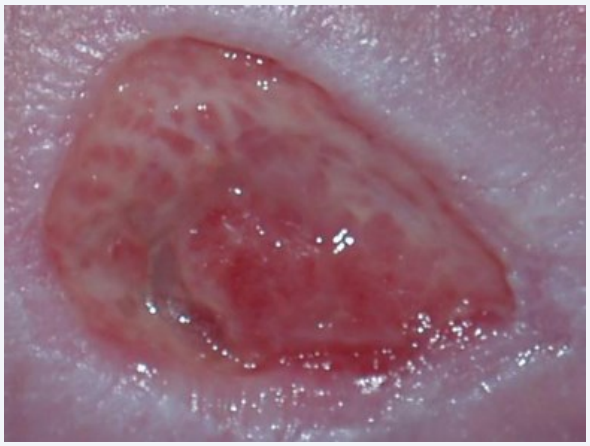
guidelines, the ability to obtain certain specialty surfaces or treatments is linked to the stage of the pressure ulcer present.

TABLE 6-6

Pressure Ulcer Tissue Characteristics

Photo	Type of Tissue and Characteristics
	**Granulation Tissue** Highly vascularized tissue that replaces the initial fibrin clot in a wound. Vascularization is by ingrowth of capillary endothelium from the surrounding vasculature. The tissue is also rich in fibroblasts (that will eventually produce the fibrous tissue) and leucocytes. (Used with permission from Aimée Garcia, MD.)
	**Fibrinous Slough** Fibrinous tissue that has separated from the surrounding or underlying tissue. Slough is yellow and interspersed with the red granulation tissue in the wound bed, and is very difficult to remove with sharp debridement. (Used with permission from Aimée Garcia, MD.)
	Necrotic Tissue Tissue that has died. Although the tissue is dead, it can still support bacterial growth, thereby leading to higher bacteria load or infection of a wound. (Used with permission from Aimée Garcia, MD.)

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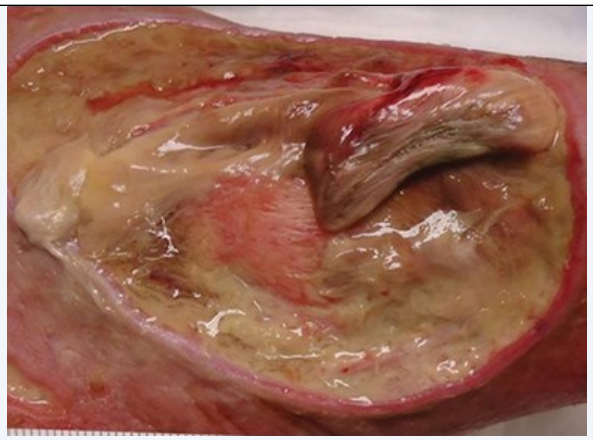

Necrotic Slough

A layer or mass of dead tissue separated from surrounding living tissue.

Necrotic slough can appear in a wound or an inflamed area and has to be debrided.

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Stable Eschar

Thick, leathery necrotic tissue; devitalized tissue.

Stable eschar is hard leathery covering with no surrounding erythema, drainage, or odor. Because the tissue is dry, it will present as a hard covering.

(Used with permission from Aimée Garcia, MD.)

Unstable Eschar

Thick, leathery necrotic tissue; devitalized tissue.

Unstable eschar is soft leathery covering of dead tissue with evidence of drainage, surrounding erythema, fluctuance, or odor. This tissue is wet in appearance with lifting of the eschar along the edges. Drainage is usually present with an unstable eschar

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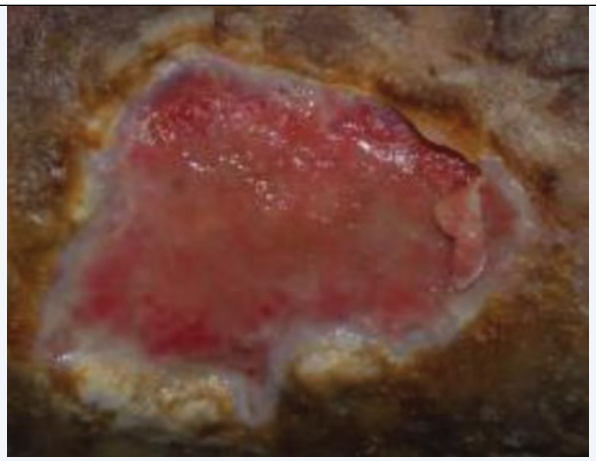	**Biofilm** A complex aggregation of microorganisms marked by the excretion of a protective and adhesive matrix. Biofilm appears as a gelatinous covering of the wound bed, but the microorganisms also invade deeper tissue and can only be seen by electron microscopy. The gelatinous covering is an indication of the bacterial colonies in the wound bed. (Used with permission from Aimée Garcia, MD.)

TABLE 6-7

Pressure Ulcer Periwound Characteristics

Photo	Tissue Characteristics
	Viable Healthy tissue at the edges of the wound that will sustain healing. (Used with permission from Aimée Garcia, MD.)

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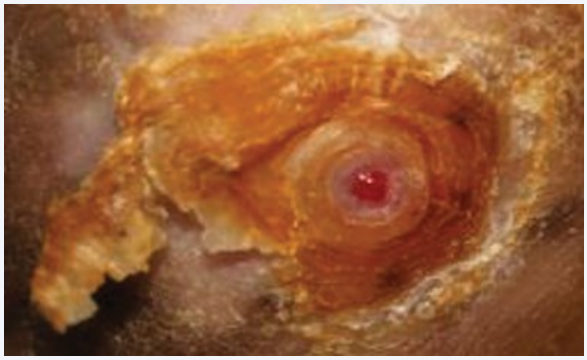
Erythematous

Bright redness that indicates the presence of inflammation and/or infection in the surrounding tissue.

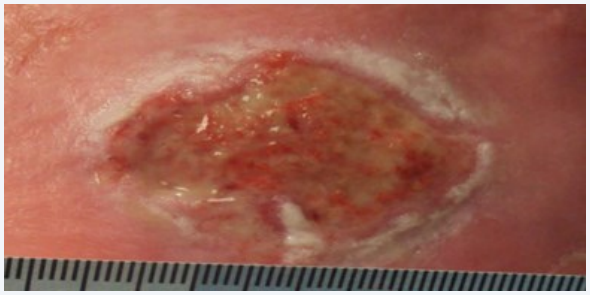
(Used with permission from Aimée Garcia, MD.)



Hyperkeratosis

Thick accumulation of the outer layer of epidermis at periwound that is nonviable.

(Used with permission from Aimée Garcia, MD.)



Maceration

Accumulation of fluid in the soft tissue surrounding the wound bed, causing it to be white and boggy.

(Used with permission from Aimée Garcia, MD.)

Rolled Edge/Epibole

Rolled wound edges that can impede wound healing by limiting migration of keratinocytes.

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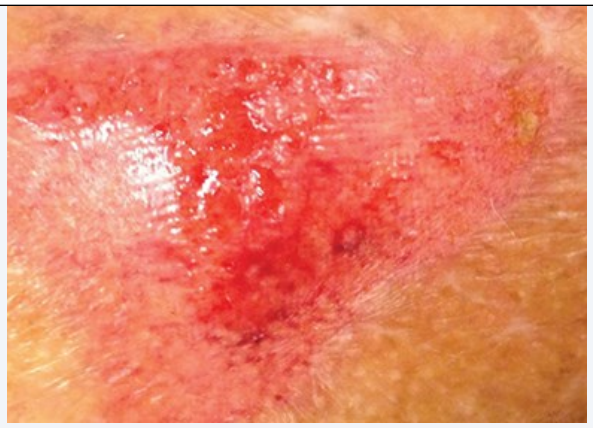
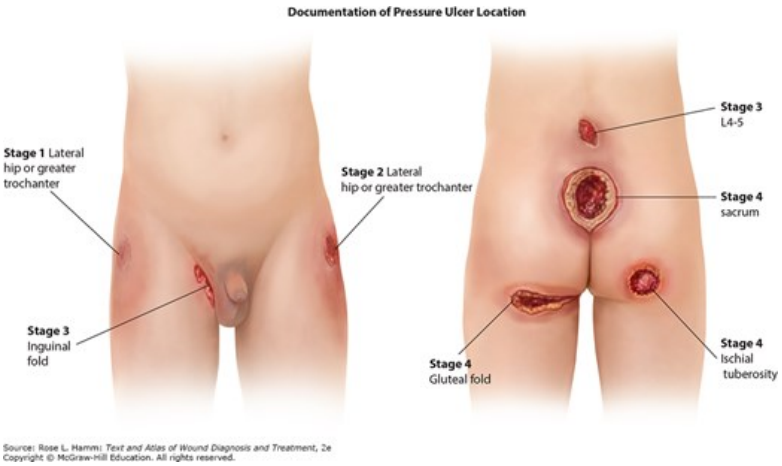


Epithelialization
Migration of a layer of keratinocytes over the surface of the wound with maturation of the stratum corneum. Note the edges of this wound that are covered with new skin. (Used with permission from Dr. Foy White-Chu.)

The anatomic location of the wound needs to be very specific. A common mistake with documentation of location is the intermingling of terms for different anatomic areas. Although one healthcare provider may document the patient as having a wound on the sacrum, the next may describe it as the lower back, buttocks, or coccyx. These areas are anatomically different and only one of these descriptions would be correct. The documentation needs to be accurate and consistent between healthcare professionals. An anatomic chart is provided that outlines common areas of pressure ulcer development (**FIGURE 6-29**).

FIGURE 6-29

Anatomic nomenclature of sacral area Accurate documentation of the pressure injury location is imperative. This schematic illustrates the correct anatomic position of the low back, sacrum, coccyx, buttock, ischial tuberosity, gluteal fold, and (lateral) greater trochanter.


Documentation of Pressure Ulcer Location
Stage 1 Lateral hip or greater trochanter
Stage 2 Lateral hip or greater trochanter
Stage 3 Inguinal fold
Stage 3 L4-5
Stage 4 sacrum
Stage 4 Gluteal fold
Stage 4 Ischial tuberosity

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The next step of assessment is determination of what is termed the *pressure ulcer stage*, which is based on the depth of tissue damage. The current National Pressure Ulcer Advisory Panel (NPUAP) staging system was last revised by the NPUAP in 2016 in which the term *injury* replaces the term *ulcer*.[43] The definitions are as follows, and **TABLE 6-8** is provided to aid in determination of staging:

- **Stage I—Pressure Injury: Non-blanchable erythema of intact skin**

  Intact skin with a localized area of non-blanchable erythema, which may appear differently in darkly pigmented skin. Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes. Color changes do not include purple or maroon discoloration; these may indicate deep tissue pressure injury.

- **Stage II—Pressure Injury: Partial-thickness skin loss with exposed dermis**

  Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister. Adipose (fat) is not visible and deeper tissues are not visible. Granulation tissue, slough and eschar are not present.

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These injuries commonly result from adverse microclimate and shear in the skin over the pelvis and shear in the heel. This stage should not be used to describe moisture associated skin damage (MASD) including incontinence associated dermatitis (IAD), intertriginous dermatitis (ITD), medical adhesive related skin injury (MARSI), or traumatic wounds (skin tears, burns, abrasions).

- **Stage III—Full thickness tissue loss**

  Full-thickness loss of skin, in which adipose (fat) is visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present. Slough and/or eschar may be visible. The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds. Undermining and tunneling may occur. Fascia, muscle, tendon, ligament, cartilage, and/or bone are not exposed. If slough or eschar obscures the extent of tissue loss, this is an Unstageable Pressure Injury.

- **Stage IV—Full thickness skin and tissue loss**

  Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer. Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur. Depth varies by anatomical location. If slough or eschar obscures the extent of tissue loss this is an Unstageable Pressure Injury.

  Category/Stage IV ulcers can extend into muscle and/or supporting structures (eg, fascia, tendon, or joint capsule), making osteomyelitis or osteitis likely to occur. Exposed bone/muscle is visible or directly palpable.

- **Deep Tissue Pressure Injury: Persistent non-blanchable deep red, maroon, or purple discoloration**

  Intact or non-intact skin with localized area of persistent non-blanchable deep red, maroon, or purple discoloration or epidermal separation revealing a dark wound bed or blood filled blister. Pain and temperature change often precede skin color changes. Discoloration may appear differently in darkly pigmented skin. This injury results from intense and/or prolonged pressure and shear forces at the bone–muscle interface. The wound may evolve rapidly to reveal the actual extent of tissue injury, or may resolve without tissue loss. If necrotic tissue, subcutaneous tissue, granulation tissue, fascia, muscle or other underlying structures are visible, this indicates a full thickness pressure injury (Unstageable, Stage III or Stage IV). Do not use DTPI to describe vascular, traumatic, neuropathic, or dermatologic conditions.

- **Unstageable Pressure Injury—Obscured full-thickness skin and tissue loss**

  Full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar. If slough or eschar is removed, a Stage III or Stage IV pressure injury will be revealed. Stable eschar (ie, dry, adherent, intact without erythema or fluctuance) on the heel or ischemic limb should not be softened or removed.

TABLE 6-8

Pressure Injury Stages

Photo	NPUAP Stages

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Stage I—Pressure Injury: Non-blanchable erythema of intact skin

Intact skin with a localized area of non-blanchable erythema, which may appear differently in darkly pigmented skin. Presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes. Color changes do not include purple or maroon discoloration; these may indicate deep tissue pressure injury.

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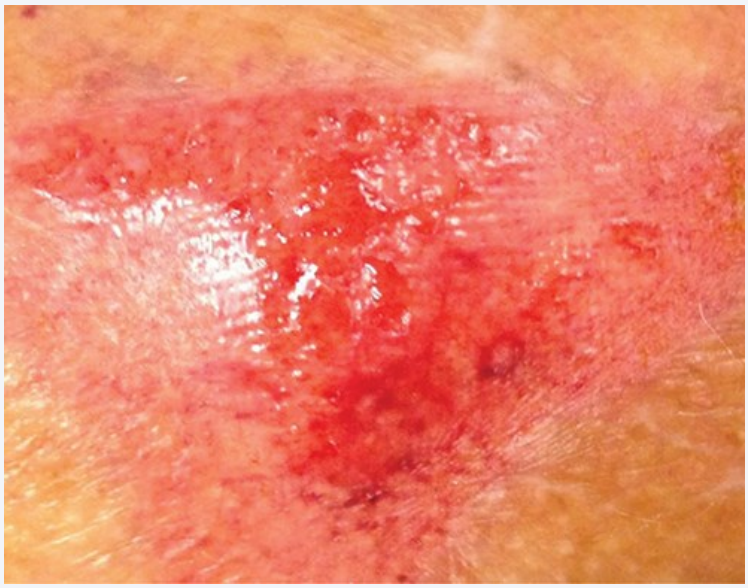

Stage II—Pressure Injury: Partial-thickness skin loss with exposed dermis

Partial-thickness loss of skin with exposed dermis. The wound bed is viable, pink or red, moist, and may also present as an intact or ruptured serum-filled blister. Adipose (fat) is not visible and deeper tissues are not visible. Granulation tissue, slough and eschar are not present. These injuries commonly result from adverse microclimate and shear in the skin over the pelvis and shear in the heel. This stage should not be used to describe moisture-associated skin damage (MASD) including incontinence-associated dermatitis (IAD), intertriginous dermatitis (ITD), medical adhesive-related skin injury (MARSI), or traumatic wounds (skin tears, burns, abrasions).

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	Stage III—Pressure Injury: Full-thickness skin loss Full-thickness loss of skin, in which adipose (fat) is visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present. Slough and/or eschar may be visible. The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds. Undermining and tunneling may occur. Fascia, muscle, tendon, ligament, cartilage, and/or bone are not exposed. If slough or eschar obscures the extent of tissue loss, this is an Unstageable Pressure Injury. (Used with permission from Aimée Garcia, MD.)
	Stage IV—Pressure Injury: Full-thickness skin and tissue loss Full-thickness skin and tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage, or bone in the ulcer. Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur. Depth varies by anatomical location. If slough or eschar obscures the extent of tissue loss this is an Unstageable Pressure Injury. (Used with permission from Aimée Garcia, MD.)

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	Deep Tissue Injury: Persistent non-blanchable deep red, maroon, or purple discoloration Intact or non-intact skin with localized area of persistent non-blanchable deep red, maroon, purple discoloration or epidermal separation revealing a dark wound bed or blood filled blister. Pain and temperature change often precede skin color changes. Discoloration may appear differently in darkly pigmented skin. This injury results from intense and/or prolonged pressure and shear forces at the bone–muscle interface. The wound may evolve rapidly to reveal the actual extent of tissue injury, or may resolve without tissue loss. If necrotic tissue, subcutaneous tissue, granulation tissue, fascia, muscle, or other underlying structures are visible, this indicates a full thickness pressure injury (Unstageable, Stage III or Stage IV). Do not use DTPI to describe vascular, traumatic, neuropathic, or dermatologic conditions. (Used with permission from Aimée Garcia, MD.)
	Unstageable Pressure Injury: Obscured full-thickness skin and tissue loss Full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar. If slough or eschar is removed, a Stage III or Stage IV pressure injury will be revealed. Stable eschar (ie, dry, adherent, intact without erythema or fluctuance) on the heel or ischemic limb should not be softened or removed. (Used with permission from Aimée Garcia, MD.)

Data from definitions as per NPUAP guidelines: www.npuap.org. Accessed December 1, 2018.

Two additional definitions provided in the 2016 revision include the following:

Medical Device–Related Pressure Injury Medical device–related pressure injuries result from the use of devices designed and applied for diagnostic or therapeutic purposes. The resultant pressure injury generally conforms to the pattern or shape of the device. The injury should be staged using the staging system (**TABLE 6-9**).

Mucosal Membrane Pressure Injury Mucosal membrane pressure injury is found on mucous membranes with a history of a medical device in use at the location of the injury. Due to the anatomy of the tissue these injuries cannot be staged.

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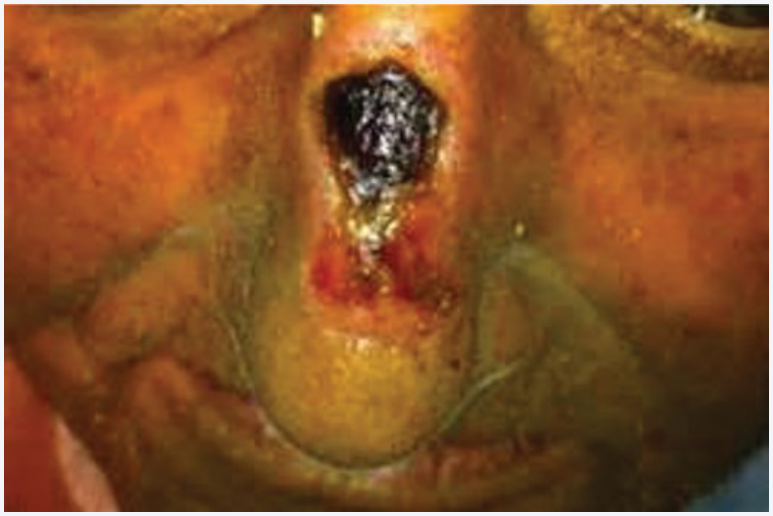
TABLE 6-9

Device-Associated Pressure Ulcers

Photo	What Is It?
	Necrosis on the bridge of the nose caused by pressure from a CPAP machine (Used with permission from Joyce Black, RN, PhD.)
	Necrosis due to oxygen tubing (Used with permission from Joyce Black, RN, PhD.)

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	Necrosis due to a patient sitting on a bedside commode for a prolonged period of time (Used with permission from Rose Hamm, DPT.)
	Necrosis of posterior neck due to taping of ET tube while the patient was intubated (Used with permission from Aimée Garcia, MD.)
	Necrosis on the knee due to a compression wrap being placed too tightly (Used with permission from Mary Sieggreen, NP.)

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	Necrosis due to a poorly fitting brace (Used with permission from Mary Sieggreen, NP.)

While it is natural to stage pressure injuries that are progressing to the next level, pressure injuries that are healing are *not* staged in reverse. For instance, if a Stage IV is granulating so that the exposed muscle is no longer visible, it is termed a Stage IV in the proliferative healing phase; it is not termed a Stage III. If that same Stage IV is closed with a surgical flap, it is termed a Stage IV in the remodeling phase even after the surgical incision is closed. Proper description of both stage and healing phase is important for DRGs, reimbursement, and other legal considerations.

What Is *Not* a Pressure Injury or Ulcer?

One of the issues that frequently arises during assessment of patients with wounds is that many different types of wounds that are *not* pressure injuries are labeled as pressure injuries. The NPUAP staging system that was described above is only to be used for the staging of pressure injuries and ulcers. All other wounds should be described by their etiology and level of tissue damage (e.g. abrasion, partial thickness, or full thickness). **TABLE 6-10** outlines different wounds that may be misdiagnosed as pressure-related wounds, including incontinence associated dermatitis, abscesses, burns, skin tears, inflammatory wounds, and malignancies. The clinical history of the wound development provides a clear understanding of the etiology. If, for example, the patient has been experiencing significant bowel incontinence due to diarrhea, the superficial skin breakdown on the buttocks region is probably incontinence-associated dermatitis, as the primary cause is the contact of the stool against the skin and not pressure. An abscess may initially look like a pressure ulcer; however, after it has ruptured or been lanced, the wound does not resemble a pressure ulcer. If the patient with the wound presented in **TABLE 6-9** as an abscess presented to the hospital from a nursing home with the wound shown, and no clinical history were known about how the wound developed, this wound would likely be misdiagnosed as a pressure ulcer. If, however, it were documented or reported that the patient had developed an area of induration with associated pain, redness, and swelling, and the site had opened with copious amounts of purulent drainage, the clinical picture would be significantly different.

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TABLE 6-10

What Is Not a Pressure Injury?

Photo	What Is It?
	Incontinence-Associated Dermatitis Breakdown of the skin due to contact with moisture, which leads to superficial desquamation; can be associated with secondary candidiasis. (Used with permission from Dr. Foy White-Chu.)
	Abscess Deep necrotic autolysed tissue, often infected, with hard, warm, indurated skin. Abscesses either spontaneously open or need to be opened and drained, leaving a defect. The wound would be defined as full thickness, but is not staged. (Used with permission from Aimée Garcia, MD.)

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Burn

The irregular shape of this wound and the location (not over a bony prominence) indicate another process. In this case, the patient spilled hot liquid over the leg, causing a full thickness burn.

(Used with permission from Aimée Garcia, MD.)

Infection

This wound in the anterior leg is secondary to infection, which led to skin necrosis. The location of necrosis indicates that pressure was not the wound etiology.

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Skin Tear

The skin in elderly individuals can be very thin, leading to superficial tears involving the epidermis and dermis. Frequently, a flap of skin is seen where the skin peeled back and may or may not survive the healing process.

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Inflammatory Wounds

This wound is atypical in appearance, has a violaceous border, and is located on an area not typically associated with pressure. The diagnosis in this case is pyoderma gangrenosum.

(Used with permission from Aimée Garcia, MD.)

Malignancy

This patient has an ulcerative lesion in the neck. This wound is secondary to squamous cell carcinoma of the head and neck.

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CASE STUDY

Mrs. S undergoes surgical intervention to repair the hip fracture. She receives a total hip arthroplasty and postoperatively is at full weight-bearing status. At postoperative day #5, she is found by the nursing staff to have a blood-filled blister on the right heel. In addition, she is found to have a superficial area of skin breakdown on the sacrum. The sacral wound is partial thickness and there is no evidence of necrotic tissue. She is scheduled to start physical therapy, but there is concern about the heel breakdown. As a result of Mrs. S's immobility and the pain medication she is receiving, she has been having issues with constipation. This has caused her to have decreased appetite.

DISCUSSION QUESTIONS

1. How would the patient's heel pressure injury be staged?
2. How would the patient's sacral pressure injury be staged?
3. What elements of the wound examination would be used to thoroughly document this wound?

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TREATMENT OF PRESSURE INJURIES AND ULCERS

Treatment of pressure injuries and ulcers depends on the clinical presentation of the wound. The mainstays of treatment are debridement, maintaining a moist wound environment, decreasing bacterial load, and pressure redistribution. Necrotic tissue in the wound is removed by debridement unless the patient's clinical picture or goals of care preclude this course of care. Debridement of a wound serves several goals: it removes necrotic tissue which is a harbor for bacteria, it allows the clinician to determine depth of tissue damage and to accurately stage the pressure injury, and it converts a chronic wound to an acute wound. There are five main types of debridement that can be used to remove necrotic tissue: sharp, enzymatic, mechanical, autolytic, and biologic. In addition, laser debridement and ultrasonic debridement are being utilized more frequently in the wound care field.[44] **TABLE 6-11** provides an outline of the main types of debridement used in pressure ulcer management. A thorough discussion of the types of debridement and when they are most appropriate is presented in Chapter 12, Wound Debridement. In addition to standard of care as described, adjunct therapies have been shown to be beneficial in facilitating wound healing, including pressure injuries and ulcers (**TABLE 6-12**). Specific parameters for treatment are found in the chapters on biophysical technologies.

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TABLE 6-11

Types of Debridement Used for Pressure Ulcers

Type of Debridement	Examples	Advantages	Disadvantages
Sharp debridement	Scalpel, scissor, dermal curette	• Fast • Selective	• Requires expertise • Risk if patient on anticoagulation • Level of comfort of practitioner • Availability of equipment • Painful • May require OR time
Autolytic debridement	Manuka honey Hydrocolloid Hydrogel Film	• Painless • Does not require expertise	• Slower acting • Not for moderate draining wounds
Enzymatic debridement	Collagenase (Santyl®)	• Selective • Does not require expertise	• Slow acting • Requires a specific pH range (6–8) • Availability may be limited • Cost
Mechanical debridement	Wet-to-dry Pulsatile lavage Whirlpool	• Easily accessible • Does not require expertise (except pulsatile lavage)	• Non-selective • Painful • Labor intensive • Availability • Infection control
Biologic debridement	Maggot therapy	• Very selective • Not painful • Movement of larvae increases blood flow	• "Ick" factor for both practitioner and patient • Availability • Complexity of dressing to contain larvae

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TABLE 6-12

Use of Biophysical Technologies for Treating Pressure Injuries

Technology	Indication
Electrical stimulation	Stage II, III, or IV that has not made significant improvement after 30 days of standard treatment (CMS regulation)
Negative pressure wound therapy	Stage III or IV that is cavernous and has been debrided; recommended to have <30% necrotic tissue in the wound bed
Non-contact, low-frequency ultrasound	Deep tissue injury
Pulsed lavage with suction	Stage III or IV that is necrotic and/or draining, in conjunction with sharp debridement
Hyperbaric oxygen therapy	Pressure-related ulcers on the foot of a patient who has diabetes
Ultraviolet	Stage II, III, or IV that is suspected to have bioburden
Low-level laser therapy	No evidence supporting use for pressure ulcers

CASE STUDY

Mrs. S's heel now has soft necrotic tissue with surrounding erythema, light serous drainage with associated odor, and pain. She is limited in her ability to do physical therapy by the pain in her foot. The patient's sacral pressure ulcer now has a thin layer of yellow slough, but no evidence of periwound erythema. There are no signs or symptoms of infection. The attending physician wants to transfer the patient to a skilled nursing facility for ongoing physical therapy and wound care, but they need recommendations on how to treat the wounds on the heel and the sacrum.

DISCUSSION QUESTIONS

1. What debridement techniques are optimal for the patient's heel given her clinical picture? For her sacrum?
2. What are the possible complications that can occur due to the deterioration of the heel?

COMPLICATIONS OF PRESSURE ULCERS

Pressure ulcers can lead to multiple clinical complications, including wound infection, abscess formation, osteomyelitis, sepsis, and death. Infected pressure ulcers are one of the leading causes of infection in long-term care facilities, and can lead to sepsis.[45–47] Because of the cellular changes that occur as a result of the disease process, patients with diabetes have a tenfold increase in developing and being hospitalized for a soft tissue or bone infection of the foot.[48] The level of bacteria in the wound bed includes colonization, critical colonization, and infection.[49] Colonization means there are bacteria in the wound bed that are not negatively impacting wound healing. All wounds are colonized because there are bacteria on the skin and in the environment. The level of bacteria in the wound bed has not reached a level where they are impeding wound healing. Critical colonization refers to a level of bacteria in the wound that is interfering with wound healing. At this level, the bacteria are causing inflammation and further breakdown of tissue, thus preventing the wound from healing. Finally, an invasion into the soft tissues with resultant inflammatory changes is considered infection.

If the pressure ulcer has extensive necrosis or is close to the anus, thus increasing the risk for contamination with stool, surgical procedures such as debridements, diverting colostomies, and flaps or skin grafts may be required to effectively close the wound. Patients who develop larger or more

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complicated pressure ulcers frequently require extended admissions to long-term acute-care facilities or skilled nursing facilities for management of the wound, thus increasing the cost to the healthcare system.

In addition to treating the wound and providing effective pressure redistribution, the overall medical condition of the patient is critical to wound healing, especially as it applies to nutrition, medications, and psychosocial factors. These issues are discussed in Chapter 11, Factors That Impede Wound Healing, and apply to both prevention and treatment of pressure ulcers.

SUMMARY

In summary, the goals of healthcare providers are early assessment for risk of pressure injury and ulcer development, implementation of preventive strategies, and if a pressure injury should develop, comprehensive assessment of the wound and early aggressive treatment to prevent further deterioration. Through education of healthcare providers, a decrease in the impact of pressure ulcers on the healthcare system and improvement of patient care and quality of life are achievable outcomes for the multidisciplinary medical team.

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